POWER PLANT ENGINEERING

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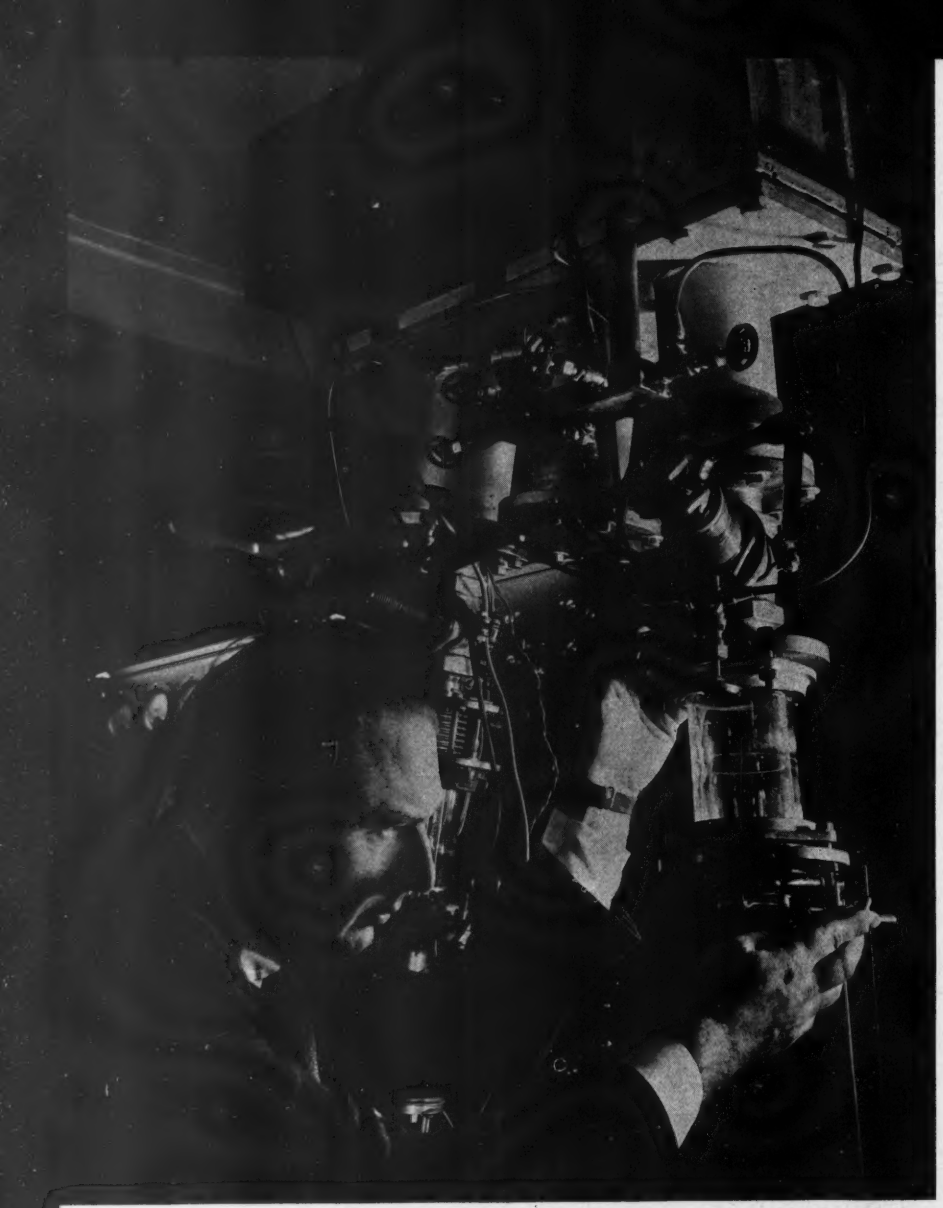


The analyzing chambers of the new Westinghouse "atom-smasher" at East Pittsburgh, Pa.

THE ALCHEMIST

NO ALCHEMIST OF OLD was ever more intent in his efforts to achieve transmutation than is the modern alchemist in his efforts to put transmutation to practical use. For the modern scientist the mere achievement of transmutation has long lost its novelty since it has been done again and again. His efforts, now, are being directed to putting the accomplishment to some use and recent developments provide promise of considerable success in this direction. ¶ One of the first uses of transmutation or atomic disintegration processes was the production of artificial radioactivity in substances ordinarily not radioactive. On page 58 of this issue we present a photograph of a small pellet of radioactive radium which was produced by bombarding ordinary radium with heavy hydrogen nuclei. Such artificial radioactivity lasts only a few days but during that time it can be used in much the same way as radium. ¶ In another direction interesting results have been obtained in actually splitting atoms of uranium into two almost equal parts. As pointed out in the report of the A.I.E.E. Convention on page 60 at that meeting Dr. Enrico Fermi and his colleague Dr. Dunning of Columbia demonstrated this "fusion" of uranium by bombardment with neutrons with an accompanying release of energy far greater than anything yet brought about by man. The most interesting aspect of this experiment is that it may result in a chain reaction in which the fusion of one atom would result in the fusion of two or more others, thus giving rise to a self perpetuating nuclear reaction with the consequent release of large amounts of energy.

WITH THE EDITORS

More Power From Coal

FOR SOME unexplained reason, very few power companies include, in their annual reports to stockholders, an item dealing with the character of the fuel used and the economy secured in the production of power. This seems strange when it is recognized that fuel costs are items of major importance in the operation of a steam power plant, and this item is about the only one in a report that permits comparison of operating efficiency with other companies. The Detroit Edison Co. sets an example in this, as it has done in so many other phases of company operating policies, by publishing in its report a brief but sufficiently complete paragraph on fuel to give stockholders, who are familiar with fuel economy, data by which they may judge the excellent character of the engineering work that is being done by the Detroit company. We quote the entire paragraph:

"Our steam power plants consumed 1,416,622 tons of bituminous coal bought in Kentucky, Virginia and West Virginia, and the equivalent of 66,537 tons in blast furnace and oil refinery gas bought locally. The average price of coal was $3.78 per ton, substantially the same as in 1938. As heretofore, 39 per cent of the cost was the price of coal at the mines and 61 per cent the cost of freighting it to us by rail and lake. Improvement in power plant efficiency made it possible in 1939 to generate each kilowatt-hour of net output with 0.96 lb. of coal. This required an even pound in 1938, and 1.27 lb. in 1929."

This is indeed an enviable record, far surpassing the average utility fuel economy which in 1930 was 1.62 lb. and, in 1938, 1.42 lb. of coal per kilowatt-hour. Even in 1929, Detroit Edison Co.'s fuel economy surpassed considerably the average of today, so it may truthfully be said that the engineering accomplishments of this company are ten years ahead of the average in the field of power utilities.

Due in large measure, no doubt, to the engineering acumen of Alex Dow, president of the company since its incorporation in 1903 and whose retirement from that position has just been announced, this company has placed great emphasis on the engineering phases of company operations. In addition to an efficiently organized engineering department that handles all construction and operation problems, the company has for years maintained a research division that has contributed extremely valuable information in all phases of power generation and utilization, particularly those having to do with combustion, piping, and the use of steam at high temperatures and pressures. The policies of the company dealing with the management of engineering activities is well summarized in one of the closing paragraphs of the report to stockholders which reads:

"Successful conduct of our business requires that we anticipate many coming events, with such foresight as is given to us. New steam turbines must be ordered two years before they are needed. Other construction work must be prepared for at least a year ahead. Our working estimates of revenues and expenses, of cash resources, coal requirements, and materials to be needed, never run less than six months into the future. Sometimes our judgment is good and sometimes it is not. The protection against poor guesses is constant watchfulness, and quick revision when prospects seem to alter."

A little over a generation ago, when power was measured almost exclusively in horsepower, engineers dreamed, almost without hope of accomplishment, of generating one horsepower-hour with one pound of coal. That meant reducing coal consumption to about one-fifth of the best records of the day. With a whole year's record averaging 0.96 lb. of coal per kilowatt-hour of power generated, the dream has considerably more than come into being. The answer, we believe, is company policies that support modern engineering progress.

Honors to Modern Pioneers

IN UNISON with the National Association of Manufacturers, everybody in the power plant field has reason to join in honoring the Modern Pioneers who are on the American frontiers of industry.

It was one hundred and fifty years ago that the American patent system was founded, and with all the faults it possesses and the abuses developed around patent laws, there have been few legislative enactments that have stimulated more improvement in the American standard of living than the patent laws of the United States as they were originally enacted and amended up to their present form.

This anniversary inspired members of the National Association of Manufacturers, who have recognized the social value of employing scientific and engineering knowledge for improving every phase of human living conditions, to honor those in the front line of modern industry whose work has increased employment, provided a new commodity or service, reduced the cost of a product already in use, or improved the quality of a product already in use.

During these days when an endeavor is being made to change radically our patent laws, this public attention given to what progress is being made, almost as a direct result of the protection given to patentees under our present laws, should arouse interest among individuals and organizations that will be helpful in securing an extremely careful and analytical study on the part of Congress when considering modifications of the existing patent laws.

Bethlehem

By H. K. MILLER
Combustion Engineer
Steelton Plant
Bethlehem Steel Co.

Fig. 1. Blast furnace gas, coke breeze and anthracite silt are burned in three 125,000 lb. per hr., 250 lb. boilers

AT BETHLEHEM'S STEEL CO.'s Steelton Plant, Steelton, Pa., a new boiler plant has been built to replace five smaller steam plants, some of which had been in service 30 yr. or more. While the less efficient older units are being scrapped, others of more recent design will be maintained as emergency units. Waste heat boilers on open hearth furnaces that were also an important source of steam are to be retained. Outstanding advantages of the new plant will be a reduction in cost of steam by more than one-half and greatly increased flexibility of control and availability of power, resulting from the centralizing of steam production in one unit.

The Steelton Plant consists of a main steel making division and a smaller section about 2 mi. distant where some manufacturing operations and a by-product coke plant are located. One of the unusual provisions in connection with the new installation is the arrangement that has been made to pipe steam from the central station in the steel division to the 2-mi. distant departments. The Steel Division comprises blast furnaces, open hearth, rolling mills, forge department, steel foundry and repair shops.

These departments were interconnected so as to receive their steam supply from six waste-heat boilers on open-hearth furnaces and two separate fuel-fired boiler plants containing a total of twelve 500-hp. and six 250-hp. water-tube boilers erected more than 30-yr. ago. These boilers were fired by blast-furnace gas, coke breeze, or bituminous coal. The solid fuels were fired entirely by hand and ash removal required much manual labor, resulting in high labor costs. The firing of blast-furnace gas over hand-fired grates precluded the possibility of good combustion efficiency, and the steaming capacity was limited. The physical condition of boilers and settings was poor after the many years of hard usage.

Coke ovens, frog and switch department and fabricating department were built somewhat later than the Steel Division and are located in a group about 2-mi. to the east. Originally each of these three departments had its own independent boiler plant. Later on these three steam systems were interconnected and it was rarely necessary to operate more than two of the boiler plants. At the coke ovens, the boilers were installed originally for waste-heat operation. They were later converted for firing with coke-oven gas and are held in reserve for operation in emergency or at times when there is an excess of coke-oven gas. Each of the other two boiler plants contains four 250 hp. boilers; hand-fired in one plant and in the other fired with oil. It is intended to dismantle the hand-fired plant, but the other will be retained as an emergency unit.

Electrical Supply

Electrical energy for the operation of the entire Steelton Plant is supplied from a generating station containing three 3500-kw. gas-engine-driven generators operating on blast-furnace gas and one 4500-kw. steam turbogenerator. For use at times when the gas engines are not available, there is a 7000-kw. generating station supplied with steam from the general steam system.

About two-thirds of the electric-power requirement is supplied by the blast furnace gas-engine units and the balance by the steam turbine-driven unit. Steam also is used for operation of steam-hydraulic presses and hammers at the forge department, for operation of gas producers and other miscellaneous process and heating requirements.

Poor condition, scattered locations and consequent excessive cost of operating the old boiler plants and the expenditure which would soon become necessary for replacement of the wornout boilers led to a decision to build one central station of modern design for the supply of all steam requirements of the entire Steelton Plant. This plant is conveniently located to use the blast-furnace gas available in excess of that used for stoves, gas engines and soaking pits. For the supply of the coke ovens, frog and switch and fabricating departments, a 10-in. pipe line, about 10,000-ft. long was constructed.

This single central boiler plant permits full use of all excess blast-furnace gas. Coke breeze, produced as a by-product in the operation of the coke ovens and blast furnaces, is used as an auxiliary fuel. Fine anthracite coal, which washes down the Susquehanna River from the mining districts, is

Steel Installs Central Boiler Plant at Steelton

One hundred per cent boiler feedwater makeup, 250 lb. steam line 10,000 ft. long, arrangements for firing three fuels, complete combustion control and high flexibility features of new central boiler plant built to supply prime mover and process needs with a reduction in steam cost of 50 per cent

used to make up any deficiency. This coal is obtained by dredging and washing operations carried on in the river near the Steelton Plant. Economy of a single boiler plant using blast-furnace gas and coke breeze as principal fuels, over the operation of a separate boiler plant for the supply of the three separate departments more than justifies the cost of the 2-mi. steam line with its inherent heat losses and pressure drop.

Boilers

The new boiler plant contains three boilers, with maximum continuous capacities of 125,000-lb. per hr. of steam each, designed for operation of 250-lb. per sq. in. and 475-deg. F. total temperature. The boilers are of the three-drum type each containing 10,500-sq. ft. of heating surface in the boiler proper; 2,228-sq. ft. in the water walls and arches; and 1,320-sq. ft. of economizer surface.

Selection of the steam pressure and temperature was influenced by two limiting conditions. They must be high enough to provide a sufficient pressure and temperature at the end of the two-mile steam line. and not too high for the existing turbogenerator and other steam-driven equipment in the Steel Division. The pressure of 250-lb. is at the dividing point between two classes of pipe and fittings and is ample to give a satisfactory pressure at the end of the long steam line. The temperature of 475-deg. F. is as high as was considered safe for the existing steam-using equipment.

Use of travelling grate stokers was decided upon as offering the most satisfactory method of burning the coke breeze and river anthracite in conjunction with blast-furnace gas. The use of these fuels in pulverized form, while feasible, presented problems that it was not thought advisable to undertake. The grates are 23-ft. long and 20-ft. wide and have an effective surface each of 453 sq. ft. This gives a maximum burning rate of 42.5 lb. of coal per sq. ft. per hr. when developing maximum capacity with anthracite coal alone.

Boiler furnaces have water walls front and rear and over the front and rear arches. The sides are water-walled from the grate surface to the bottom

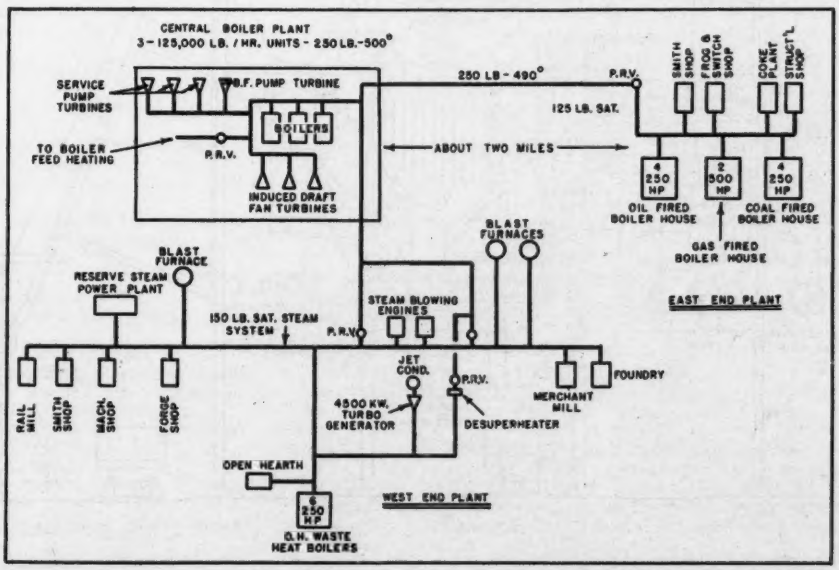


Fig. 2. Steam flow diagram showing the arrangement of the new central boiler plant built to supply steam to the adjacent steel division and also to the byproduct coke plant about 2 mi. distant. The waste heat boilers will still be operated regularly, but the other old boilers will be removed or put on standby service

drum of the boilers. The settings are of the sectionally-supported-refractory type backed with two to three inches of high-temperature and Bethlehem slagwool insulation. The volume of 7,462 cu. ft. provides for a maximum heat release of about 20,000 B.t.u. per cu. ft. There are two pre-mixing-type blast-furnace gas burners in each furnace, giving a total capacity of 20,000 c.f.m. per boiler.

Air for combustion of both blast-furnace gas and solid fuels is preheated in tubular-type preheaters having an effective surface of 10,300 sq. ft. each. Other details of design of the boilers and other equipment are given in the list of equipment.

Soot Pockets and Stoker Hoppers

In burning both coke breeze and fine anthracite coal, a quantity of the fine particles of fuel is carried back into the boiler. Hoppers have been provided at the bottom of the rear pass and under the economizers and air preheaters to receive the considerable proportion of this material that will drop out of these points. A steam-jet vacuum-removal system delivers this material over the grates in the boiler furnaces. Operating experience so far indicates a considerable improvement in efficiency resulting from this dust reclamation.

Anthracite coal and coke breeze are not mixed but the stoker hoppers are arranged in such a manner that both anthracite coal and coke breeze can be fed together. The hoppers are provided with a vertical baffle plate running lengthwise and dividing the hopper into two chambers. The chamber away from the boiler is fed with coal and that toward the boiler with coke breeze. This causes the fuel to be deposited on the grate in two layers, coal on the bottom with coke breeze on top. The baffle plate is adjustable so that the relative thickness of the two layers can be varied at will.

Control

The boiler-control system is designed to burn blast-furnace gas to its full availability and to make up the deficiency automatically with coal and coke breeze by variations in the speed of the travelling grates. This system also provides for the automatic regulation of the amount of air for combustion and for the regulation of the temperature of the air fed to the travelling grates. This latter function is accomplished by thermostatic control of a by-pass damper, which feeds a suitable quantity of cold air to the stoker wind boxes.

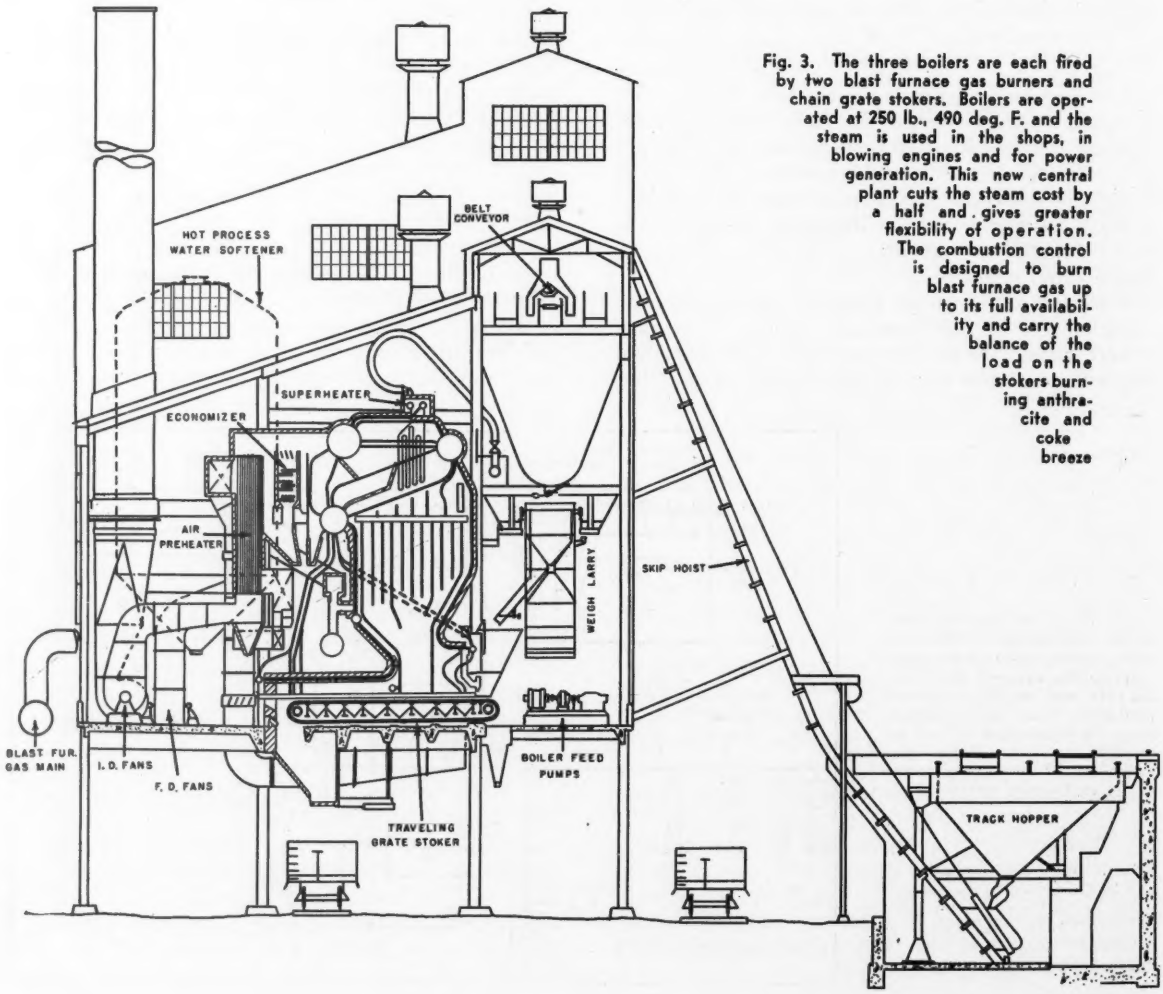


Fig. 3. The three boilers are each fired by two blast furnace gas burners and chain grate stokers. Boilers are operated at 250 lb., 490 deg. F. and the steam is used in the shops, in blowing engines and for power generation. This new central plant cuts the steam cost by a half and gives greater flexibility of operation. The combustion control is designed to burn blast furnace gas up to its full availability and carry the balance of the load on the stokers burning anthracite and coke breeze

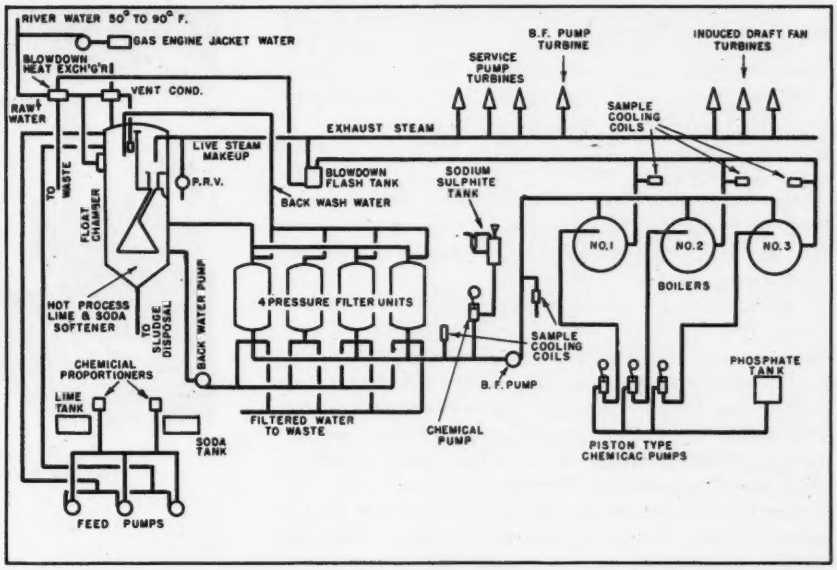


Fig. 4. One hundred per cent makeup, taken from the river, is treated in a hot process softener with a capacity of 400,000 lb. per hr. The only steam reclaimed as condensate is the auxiliary exhaust used in the feedwater heaters. This treatment is supplemented by phosphate and sodium sulphite fed directly to the boiler drums

Refractory-lined, cast-iron ash hoppers receive the refuse from the stokers and, through hydraulically-operated gates, it is discharged directly into railroad cars. Coal and coke breeze are delievered by railroad cars into a track hopper from which an automatic skip hoist carries them to a belt conveyor over the coal bunkers. The coal bunker extends the full length of the boiler house and is divided into two parts, one for coal and the other for coke breeze. A travelling weigh larry is used to deliver fuels from the bunker to the individual stoker hoppers.

Boilers are steel cased and these, as well as the gas and air ducts and the air-preheater casings, are of Mayari R, Bethlehem's high-strength, corrosion-resistant steel. This material also was used for the smoke stacks and ash and soot hoppers where this material's high resistance to corrosion is most beneficial. In the coal bunker it was possible to realize a reduction in weight of about 17 per cent by the use of Mayari R instead of ordinary steel plate.

Feedwater System and Auxiliary Drives

Jacket water from the gas engines constitutes a large proportion of the total raw feedwater. This water reaches the feedwater heater at about 140 deg. F. so that the quantity of steam required for feed heating is relatively small. In order to pro-

LIST OF PRINCIPAL STEAM GENERATING EQUIPMENT

BOILERS: 3; three-drum; bent-tube; 125,000-lb. per hr. each; 275-lb.; 500 deg F. design conditions; operating at 250 lb. 478 deg. F. at superheater outlet; heating surface 10,500 sq. ft.; water walls on two sides, front, rear, and stoker arches, block covers on arches, bare tube on walls, total surface 2228 sq. ft.

SUPERHEATERS: 3; bare-tube pendent type, 780 sq. ft. of gas touched surface.

ECONOMIZERS: 3; bare continuous tube, 1320 sq. ft. surface.

AIR PREHEATERS: 3; tubular-type; 10,300 sq. ft. surface.

FURNACE AND FITTINGS: 3 sets sectionally supported refractory settings, steel encased; furnace volume 7462 cu. ft.

STOKERS: 3 chain-grates 20 ft. wide by 23 ft. long, with 453 sq. ft. effective grate area; stokers complete with steam-engine drive and reduction gears.

GAS BURNERS: 6 pre-mixing type, two on each boiler; capacity 20,000 c.f.m. of blast-furnace gas per set.

SOOT BLOWERS: 3 sets revolving head and gun-type elements.

CINDER CONVEYORS AND BURNERS: 3 sets.

FORCED-DRAFT FANS: 3 motor-driven; capacity 50,000 c.f.m. each of 80-deg. F air at 8 in. static; direct connected to 100-hp., 3-ph., 25-cycle, 440-v. 1470 r.p.m. motors.

INDUCED-DRAFT FANS: 3 turbine-driven; capacity 100,000 c.f.m. each at 450 deg. F and at 12 in. static; connected to 260 hp. turbines and reducing-gear sets.

ASH HOPPERS: 3 cast-iron, refractory-lined with hydraulically-operated gates.

COMBUSTION CONTROL: Complete system for three steam generating units.

FEEDWATER REGULATORS: for three steam-generating units.

COAL-HANDLING EQUIPMENT: track hoppers and chutes: skip hoist and belt conveyors, capacity 70 t. per hr.; traveling weigh larry, capacity 5 t.

BOILER-FEED SYSTEM AND SPECIALTIES

BOILER-FEED PUMPS: 2 motor-drive, four-stage, single-suction, 500 g.p.m. capacity, 3500 r.p.m. 770 ft. head, each connected to a 125-hp. electric motor and speed-increasing gears. One, same type and size direct connected to a 129 hp. turbine.

WATER TREATING SYSTEM: 1 hot-process; 400,000-lb. per hr. capacity; sedimentation tank 2 ft. by 6 in. diam. by 34 ft. on straight side, 54 ft. overall height. Equipped with jet heater; deaerating atomizer; vent condenser; storage for deaerating water, 67,000-lb; storage for back-wash water, 80,000 lb; four filters 10 ft. diam. by 6 ft. high on straight side; dry chemical feeders for soda and lime; sulphite and phosphate solution tanks.

PHOSPHATE FEEDERS: 3; size 1¼ by 3 in. duplex motor-driven with automatic control for each boiler.

SULPHITE FEEDER: 1 single cylinder motor-driven.

BLOW-DOWN SYSTEM: continuous type with 7 ft. diam. by 10 ft. flash tank and heat exchanger 22 ft. diam. by 11 ft. long.

DESUPERHEATER STATION: 1 reducing-valve and desuperheater, 100,000-lb. per hr. capacity, for turbogenerator.

REDUCING VALVES: For plant steam mains: 1, 45,000 lb. per hr. capacity, East End; 1, 50,000 to 200,000 lb. per hr. capacity, West End; 1, 30,000 lb. per hr. capacity, make-up heating steam for feedwater system.

vide a quantity of exhaust steam which would secure a heat balance, the induced-draft fans, three plant service pumps and one boiler-feed pump are steam turbine driven. Two additional boiler-feed pumps are motor driven. A reducing valve connection is provided from the high pressure steam system to make up sufficient steam to maintain a constant water temperature in the hot-process softener. A flash tank and heat exchanger located ahead of the feedwater heater reclaim the heat in the continuous blow-down water.

The feedwater problem at Steelton is a particularly difficult one. The wide distribution of consuming units makes the return of condensate impracticable; consequently, all boiler feed is make-up except the steam condensed in feedwater heating. The discharge water from the gas-engine cooling system is used for boiler feed. This water is pumped from the Susquehanna River and its chemical condition varies widely and rapidly according to the stage of the river and the relative flow from the various tributaries, each of which has its own characteristics. These conditions required a system capable of coping with fairly broad and rapid changes in required treatment. At times the river water is high in suspended turbidity and unsuitable for use in these boilers without filtration.

Existing equipment had been satisfactory for the old boilers which operated at low ratings but was considered totally inadequate for the new equipment including, as it did, economizers and water walls and contemplating operation at fairly high rates of evaporation per unit of surface. In view of these conditions, it was decided to install a completely new feedwater-treating system with chemical control of sufficient flexibility to take care of the rapidly fluctuating condition.

Raw water is taken from the Susquehanna River and fed into a hot-process lime-soda softener and then through pressure filters to the boiler-feed pumps. The water is sampled after the filter as frequently as conditions require and the feeding of

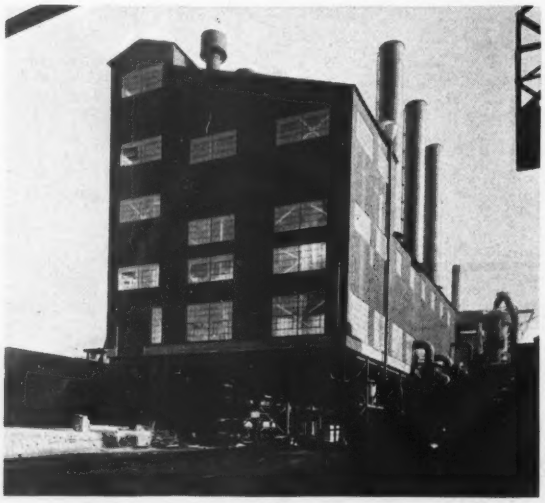


Fig. 5. The plant is built high so that freight cars can be run in under the ash hoppers

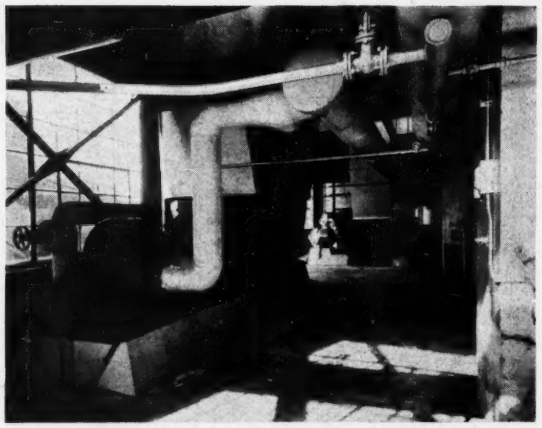


Fig. 6. Forced and induced draft fans are installed on the operating floor directly behind the boilers

sodium sulphite at the feed pump is regulated accordingly. Di-sodium phosphate is fed directly into the steam drum of each boiler; the rate of feed is automatically controlled in accordance with the flow of feedwater to the boiler. Supplementary deaeration of the feedwater is accomplished by means of sodium sulphite pumped continuously into the suction of the boiler-feed pumps. The dosage of sulphite is adjusted from bi-hourly tests of the feedwater and concentrated boiler water.

The sedimentation tank has several novel design features. It is equipped with an atomizing deaerator and separate storage chamber for deaerated water. It also has a separate storage chamber for deaerator wash water. Dry feeders are used to feed the lime and soda to the softener. Filter beds are made up with 18 in. of graded magnetite and 30 in. of graded anthracite. Deaerated water is used for backwashing and returned to the sedimentation tank in a manner which does not disturb the normal operation of the softener.

United Engineers & Constructors, Inc., of Philadelphia were retained as designing Consulting Engineers, and Sheppard T. Powell of Baltimore as Consulting Chemical Engineer in the solution of the feedwater problems.

Bonneville Power for Tacoma

RECENTLY the City of Tacoma, Wash., and the Bonneville Power Administration entered into a 10-yr. agreement for the interconnection of Tacoma's municipally owned power system with the Federal network.

The agreement will become effective immediately upon completion of necessary construction work, scheduled for this fall. Bonneville will build a 110,000 v. extension of its network to a connection point at Tacoma's city limits. The city will build a similar line from the connection point to its tideflats substation. The Tacoma contract follows by less than a week the 20-yr. contract with the Sierra Iron Co., which brings the first steel industry to the area in the wake of a previously announced 20-yr. Bonneville contract with the Aluminum Co. of America, which took that industry west of the Mississippi for the first time.

In this, the second part, of his analysis of hotel economics with respect to power costs, Mr. Douglas presents actual data on the power costs of two of the largest hotels in the world, the Stevens in Chicago and the Waldorf-Astoria in New York. The first of these generates its own steam and electric power while the second purchases both of these commodities. Figures are also presented for a smaller hotel under both conditions. All such figures are, of course, open to argument but as presented by Mr. Douglas they are of definite interest and we invite comment on them.

Part II

The Hotel Power Plant

A Stimulant For a Five Billion Dollar Convalescent Industry

By EGBERT DOUGLAS
Consulting Engineer, New York City

IN A PREVIOUS ARTICLE under this title we considered in some detail the economic aspects of the hotel power plant in relation to the industry as a whole. Now we will study the actual operating costs of two prominent hotels, one operating its own power plant and the other buying its power from outside sources. The former is the Stevens Hotel of Chicago and the latter the Waldorf-Astoria in New York City. There is no breach of business ethics in quoting these figures since they are taken from Poor's Industrial Volume. Poor's is a high class statistical publication which can be found on the library shelves of our leading banks and trust companies as well as the public utility, investment banking and insurance companies.

These two hotels are among the largest in the country and are classed as the finest in the world. Being relatively new, they are examples of the best modern practice in hotel design. Each has large amounts of public space and both cater to a high class of business. The figures quoted cover an extended period of time and should be of interest to investors, designers and hotel executives as well as engineers.

First are shown the heat, light and power costs of the two hotels over a period of approximately three years, 1936, '37 and '38.

Heat, light and power Published Costs	Stevens Hotel 2800 rooms with complete Power Plant		Waldorf-Astoria 2200 rooms having no Power Plant
10 Months of 1936.....	$145,932	(12 mo.)	$318,652
12 Months of 1937.....	188,792		311,794
12 Months of 1938.....	190,282		
Total .....34 mo.	$525,006	24 mo.	$630,446
Average per year.....	*186,000		315,223
Cost per room year.....	$65.50		$143

*This figure was adjusted for 12 months from the 10 months total in 1936 as shown in the published figures.

The Waldorf-Astoria figures are quoted as being audits by Howarth & Howarth and those of the Stevens Hotel are quoted as being audits by Arthur Anderson & Co., both reputable accounting concerns.

It is of interest to note that in 34 months the total cost of heat, light and power in the Stevens Hotel was $105,440 less than the cost of those commodities in the Waldorf-Astoria for 24 months and the Stevens has 600 more rooms than the Waldorf-Astoria.

The Waldorf-Astoria has no steam or power producing facilities; all steam and all electricity are supplied from the outside. The Stevens, on the other hand, has its own complete power plant making all of the steam, electrical and refrigeration requirements for the entire property.

On a room unit cost basis the Waldorf-Astoria figures for light, heat and power appear to be more than double the cost of the same commodities at the Stevens. The heating conditions at the Stevens moreover are more severe than at the Waldorf-Astoria. The steam required to heat a given volume of building averages about 15 per cent greater in Chicago than in New York City.

The Stevens figures include the operation of a complete laundry doing all guests' bundle work as well as the hotel linen, whereas in the case of the Waldorf-Astoria it is the author's understanding that only a portion of the laundry work is done in the hotel building, the heavy work being done outside.

When these sets of figures are compared on the basis of the same number of rooms, it seems that the Stevens is getting its heat, light and power for at least $200,000 less per year than the Waldorf-Astoria. This difference makes no allowance for the difference in winter weather and with no adjustment for the larger laundry plant which the Stevens operates. The difference as here shown is equivalent to 5 per cent on $4,000,000 and is an interesting and impressive item. This comparison indicates that in this department of large hotels may be found a toehold for a better way out to better net earnings.[1]

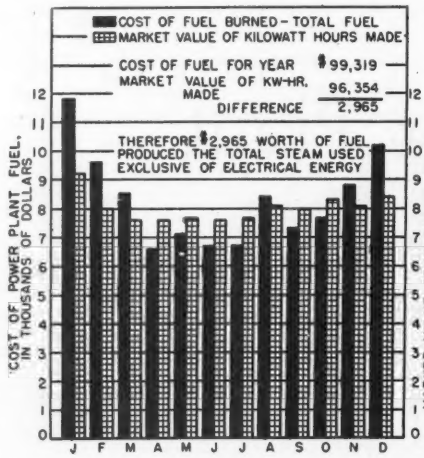

COST OF FUEL BURNED - TOTAL FUEL
MARKET VALUE OF KILOWATT HOURS MADE
COST OF FUEL FOR YEAR $99,319
MARKET VALUE OF KW-HR. MADE 96,354
DIFFERENCE 2,965
THEREFORE $2,965 WORTH OF FUEL PRODUCED THE TOTAL STEAM USED EXCLUSIVE OF ELECTRICAL ENERGY
COST OF POWER PLANT FUEL, IN THOUSANDS OF DOLLARS
MARKET VALUE OF KILOWATT HOURS PRODUCED, IN THOUSANDS OF DOLLARS
J F M A M J J A S O N D

Fig. 1. Comparison of power plant fuel costs and market value of kilowatt hours made in 1938 at the Stevens Hotel in Chicago

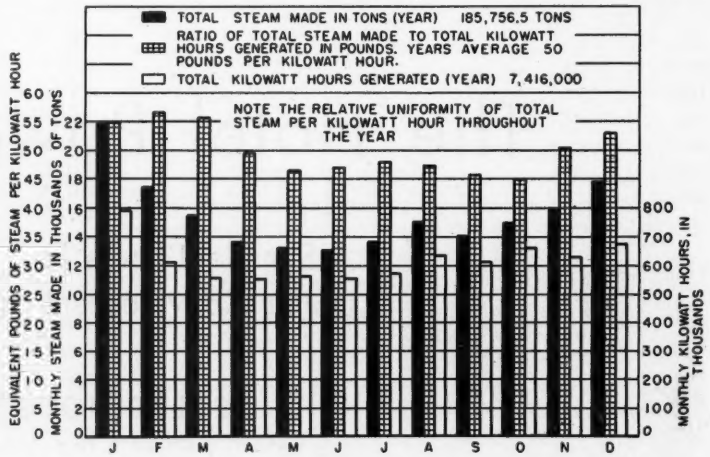

TOTAL STEAM MADE IN TONS (YEAR) 185,756.5 TONS
RATIO OF TOTAL STEAM MADE TO TOTAL KILOWATT HOURS GENERATED IN POUNDS. YEARS AVERAGE 50 POUNDS PER KILOWATT HOUR.
TOTAL KILOWATT HOURS GENERATED (YEAR) 7,416,000
NOTE THE RELATIVE UNIFORMITY OF TOTAL STEAM PER KILOWATT HOUR THROUGHOUT THE YEAR
EQUIVALENT POUNDS OF STEAM PER KILOWATT HOUR
MONTHLY STEAM MADE IN THOUSANDS OF TONS
MONTHLY KILOWATT HOURS, IN THOUSANDS
J F M A M J J A S O N D

Fig. 2. Total steam made and total kilowatt hours generated by months in 1938 at the Stevens Hotel, Chicago

The Stevens Hotel Costs from a Different Angle

The author is indebted to the Stevens Hotel Management for the following figures from their plant for the year 1938. They have given the quantities of electrical energy which the plant produced by months and the peak electric load for the year. We have also the cost of the fuel which the plant burned for the same months and the quantities of steam made.

The value of the electricity which the Stevens Hotel power plant produced has been computed. That is to say if this electrical energy had been bought on the available rate of the public utility in Chicago it would have cost a certain amount of money.

It seems reasonable to say that the kilowatt hour which the Stevens power plant produced should be

[1]Editor's Note. When the author submitted these figures and this comparison, we asked him whether in the case of the Stevens the figures covered investment and amortization charges on the power plant and pointed out that unless these figures were included the comparison was not entirely fair. Furthermore, we pointed out that there were other aspects which may or may not enter into the picture but which, if for no other reason than to show that all aspects of the problem are understood, should at least be discussed. The value of the building space occupied by the power plant for example should be considered from the standpoint of its value for other purposes. In the case of large metropolitan hotels it is quite possible that at least some of the space occupied by a power plant might have considerable rental value for use as restaurants, stores and shops or offices.

In replying to these questions Mr. Douglas writes as follows: "In the published figures . . . I am reasonably certain that fixed charges on space occupied and for investment burden on equipment required are not included in either case. In other words, the published figures are purely operating expenses as I understand them.

"Obviously the fixed charges should be taken into account in both cases and manifestly, these cannot be side-stepped by the process of purchasing steam or electrical energy. The plant that produces the services must be paid for by the user.

"I am impressed by what you say regarding the value of the space occupied by the power plant. Of course if this space can be put to a more profitable use for other purposes than a power generating plant by all means it should be done. However, such other uses as this space may be taken for as a restaurant as you mention, the restaurant should be charged the same fair rental as that applied to the power plant. I believe that is sound reasoning. . . . The Stevens power plant is located on the lowest level of the building which is either the third or fourth basement. It is not reached by the passenger elevators and only freight cars run to this level. There is no direct entrance from the street. In this space there is a good deal of apparatus which would necessarily be there if all the electricity were purchased. In Chicago the boilers would be necessary because there is no general steam distributing system. Therefore, in allocating space charges against the power plant we immediately run into more or less difficultly as to where and how to draw the line equitably and fairly.

"The Stevens electric generating plant consists of five Corliss engine driven generating units aggregating 3100 kw. of generating capacity. Three of these units are 750 kw. each direct connected to cross compound engines and there is one 500 kw. unit and a 350 kw. unit driven with simple Corliss engines.

"This electric generating plant does not represent an investment of more than $310,000 which is equivalent to $100.00 per kilowatt ready to operate. This is probably all of the excess investment that is involved due to generating the electric power and light.

"Apparently the Stevens Hotel gets it heat, light and power for at least $200,000 per year less than these services cost the Waldorf-Astoria by means of purchasing steam and electricity. If we analyze the situation on this basis the electric generating plant returns its full cost apparently every year and a half it operates.

"If the boiler plant is taken into account I should say that the total investment in the Stevens Hotel plant that has to do with steam and electric services is not more than $700,000. This is equivalent to about $225.00 per kilowatt of electrical generating capacity installed, which in my opinion is not an unreasonable guess.

"Assuming that is a fair measure of the investment and if we can accept the $200,000 figure as fairly representing the plant's gross savings, we have a gross earning of about 28½ per cent on a $700.00 investment. This as I see it is not a bad gamble when dealing with absolute necessities in the hotel business.

"We might argue this matter from another angle. For example, suppose the Stevens plant is set up as a separate department and capitalized at $1,000,000. Now if this plant sold electrical energy and steam to the hotel at the ordinary rates for these services, would the plant yield a reasonable return on the capitalization? I think it would very decidedly do so."

worth what this kilowatt hour would have cost if purchased. The value of the electricity and the cost of the fuel presents an interesting picture. The figures are shown graphically in Fig 1 and in tabulation form below.

Month 1938	Kilowatt Hours Generated	Market Value of Electricity Generated	Cost of Total Fuel Plant Burned	Fuel Cost Over or Under Current Value
January ..	795,000	$ 9175.84	$11,837.47	+2661.63
February .	617,000	8018.84	9,555.03	+1536.19
March	557,000	7628.84	8,516.15	+ 887.31
April	555,000	7615.84	6,577.43	—1038.41
May	563,000	7667.84	7,072.76	— 595.08
June	557,000	7628.84	6,698.20	— 930.64
July	570,000	7763.34	6,699.49	—1063.85
August ...	635,000	8135.84	8,412.23	+ 276.39
September	611,000	7979.84	7,258.64	— 721.20
October ..	659,000	8291.84	7,711.38	— 580.46
November.	627,000	8083.84	8,818.64	+ 734.80
December.	670,000	8363.84	10,161.33	+1797.99
12 mo.	7,416,000	$96,354.08	$99,318.75	+2964.67

On this method of analysis it will be noted that the Stevens Hotel power plant produced $96,000 worth of electricity with $99,000 worth of fuel. This fuel not only produced the electric light and power but it also heated all of the water used by the laundry and the hotel. It also heated the building and made the high pressure steam which was used by the kitchens and the laundry. This fuel also produced the refrigeration and ice.

The difference between the actual cost of the power plant fuel and the market value of the electrical energy which the fuel produced is less than $3000.00 for one year. In other words, if the electricity is worth the market price, the Stevens Hotel, with 2800 rooms, obtained its entire steam for all uses except that of electric power production for a fuel cost of about $1.06 per room per year.

It is interesting to note that in 6 months out of the year the electricity value exceeded the fuel cost by about $5000.00. The entire fuel cost for all heat, light and power requirements on the room unit basis using 2800 rooms is equivalent to $35.47 per room per year including electricity .

The Stevens Hotel Power Plant Labor Crew

Of course, power plants cannot be operated and maintained without a competent operating crew. However, even if the Stevens Hotel had no electric generating plant but operated only boilers for its steam requirements, there would still be required a crew of men for the boiler room. There would also have to be competent engineers on watch 24 hours per day to look after the refrigeration machinery; the water pumping; the sewerage pumps; the air cooling apparatus and the water heating and house system. Therefore the operating labor problems would not be materially simplified by the elimination of the electric generating plant.

The Stevens power plant crew consists of 15 men who devote their entire working time to the boiler and engine room operation and maintenance.

Engine Room Crew	Boiler Room Crew
3 Operating Engineers	3 Firemen
1 Relief Engineer	Same relief as oilers
1 Wiper and Cleaner	2 Ash Men
3 Oilers	1 Boiler Repair Man
1 Relief Oiler	
9 Men	6 Men

Total boiler and engine room operating crew 15 men. If the entire 15 men could be eliminated it would not materially simplify the hotel labor structure. Fifteen people more or less on the pay roll of the Stevens Hotel is not a serious item. If we allocate this crew against the number of rooms in the hotel we find that one man in the power plant serves heat, light and power to 186 rooms. Hotels are relatively large employers of labor, averaging about one employee for every 3 or 4 rooms. The power plant labor crew fades away into an insignificant figure when compared to the total hotel payroll. With the large amount of mechanical, electrical and refrigerating equipment that is necessary, a considerable part of this crew would be essential if there were no power plant in the hotel at all.

An Indication of the Heat Recovery from the Electric Generating Plant

The management of Stevens Hotel and its chief engineer have very kindly provided the quantities of steam and the kilowatt hours of electrical energy produced for the 12 months of 1938.

An analysis of these figures discloses an unusual heat balance and it reflects much credit on the designers of the plant. It is also pertinent to state that the chief engineer of the Stevens Hotel had no small part in the design of this plant. He was connected with the enterprise from its inception and much of the excellent economies are due to his skill in participating in the design.

The quantities of steam produced and the kilowatt hours of electrical energy generated by months for the year 1938 appear as follows:

Month 1938	Total Steam Made in Thousands of Pounds	Total Kilowatt Hours Made	Total Steam Pounds per kw-hour Generated
January	43,495	795,000	54.6
February	34,965	617,000	56.6
March	30,951	557,000	55.5
April	27,388	555,000	49.5
May	26,242	563,000	46.5
June	26,124	557,000	46.8
July	27,304	570,000	47.9
August	29,932	635,000	47.2
September	28,006	611,000	45.8
October	29,762	659,000	45.3
November	31,605	627,000	50.5
December	35,739	670,000	53.3
12 months	371,513	7,416,000	50.0

It is interesting to note the very uniform ratio of the total steam made to the total kilowatt hours produced. Also it is remarkable to note that only 50 lb. of gross steam is made per kilowatt hour generated for the entire year. When it is realized that the Stevens Hotel has a building volume of 22,000,000 cu. ft. of space to heat, the heat recovery is indeed a creditable reflection on both the designers and the management of the plant. These figures are shown in graphic form in Fig. 2.

It may be questioned that to compare the published costs of heat, light and power is not a conclusive answer to the problem—even in this particular case of two such prominent and large hotels. There may be differences in the accounting systems of the two hotels which might explain away a portion of the vast difference which is over 2 to 1. Differences in

accounting methods, however, can hardly explain away such tremendous differences in actual money costs. These figures clearly indicate a situation which is worth serious study not only by hotel executives but also by hotel investors.

The acid test in the case of the Stevens Hotel figures for the 1938 operations is the market value of the electrical energy which the plant produced. What is a kilowatt hour worth? It seems reasonable to say that it is worth what it would cost to buy it. There is only one quality of kilowatt hours and in Chicago all kilowatt hours are produced by means of making heat. Incidentally this holds true also for New York City and in most of the larger cities of the entire country.

What is disclosed here is not new nor is it brought about by the comparative youth of the Stevens Hotel plant. It is due entirely to five things:

First, a very excellent heat recovery from the power producing equipment. This means good design.

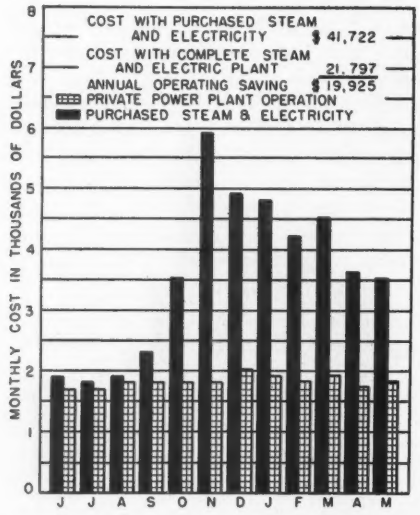
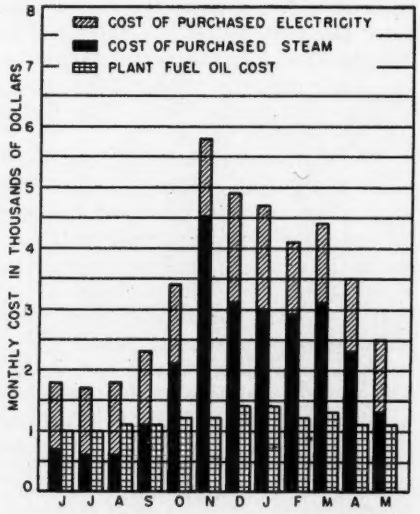

COST WITH PURCHASED STEAM AND ELECTRICITY $ 41,722
COST WITH COMPLETE STEAM AND ELECTRIC PLANT 21,797
ANNUAL OPERATING SAVING $ 19,925
PRIVATE POWER PLANT OPERATION
PURCHASED STEAM & ELECTRICITY
MONTHLY COST IN THOUSANDS OF DOLLARS
0 1 2 3 4 5 6 7 8
J J A S O N D J F M A M

Fig. 3. (Left) Operating costs for heat, light and power in a 400 room high class apartment hotel. Building volume 2,300,000 cu. ft.

Fig. 4. (Right) Comparison of purchased steam and electricity costs and private power plant fuel costs for the same services for a 400 room high class apartment hotel


COST OF PURCHASED ELECTRICITY
COST OF PURCHASED STEAM
PLANT FUEL OIL COST
MONTHLY COST IN THOUSANDS OF DOLLARS
0 1 2 3 4 5 6 7 8
J J A S O N D J F M A M

Second, a very excellent load on the boiler plant brought about by mixing the electric power load on the same boiler as the other steam requirements.

Third, a businesslike operating organization in charge of the plant. The crew runs the plant. The plant does not run the crew.

Fourth, a complement of instruments to tell the plant management what is taking place every hour of the day and night; and

Fifth, a system of power plant records that are kept regularly and accurately day in and day out.

No hotel would purchase $100,000 worth of meats, groceries, liquors or linens without a very minute check on where these goods went and what they returned in earnings.

By the same token why should not the $100,000 worth of fuel be accounted for in a similar manner? Of course, the system can be made so elaborate that it would cost more to run the system than it would to run the plant.

There may be those who contend that such results as outlined can be accomplished only in the large properties. We will now examine a small property, one of about one-tenth the size of Stevens Hotel when measured by the cubical volume of the building. The Stevens Hotel building has a cubage of 22,000,000 and the small property which we will next discuss has a cubage of 2,300,000.

We have for comparison under the two conditions a high class combination permanent apartment and transient hotel located in the best section of New York City. The building has a total volume of 2,300,000 cu. ft. and a total of 400 rooms, with first class elevator facilities and a considerable amount of air conditioned space. It has excellent eating accommodations and enjoys a high class business.

This property formerly purchased all of its steam and electric services for several years. Now it produces both steam and electricity in its own power plant. In the accompanying tabulation the total expense of heat, light and power for the 12 months ending November 30, 1937, stand in comparison with the previous expenses when both steam and electricity were purchased.

Since this comparison is for the same property with operation under the same management, it reflects cost differences which are very interesting.[2]

This particular plant is fired with oil. It is a model in appearance and also in the small number of operators required. New York City is particularly fortunate in having available at tidewater an ample and dependable supply of oil fuel at prices which make it very attractive. Oil fuel greatly simplifies the operating problems and make it much easier to maintain high operating efficiencies in the boiler plant.

With a property of this type and size a net earning of $250 per room is considered a good return. On the

Continued on Page 57

[2]Editor's Note. Here again, as in the case of the large hotels, the fixed charges against the power plant are not included and it must be understood that the figures shown here are all savings. There are many other angles to consider in a fair comparison, and it is unwise to draw too many conclusions merely from a comparison of the cost of purchased power and operating costs. While the fact that the hotel power plant, properly designed, can make use of its exhaust steam it is quite possible that in many cases a considerable amount of this exhaust steam cannot be put to effective use in the summer months. If this is the case the higher thermal efficiency of the hotel plant as compared with a "condensing" plant cannot be fully attained.

It's Your Furnace

Furnace design of the modern small boiler must consider many factors, from the spacing of the building columns to the boiler circulation. The operator sets the conditions, the designer meets them if physically possible. Close cooperation of the two is essential for satisfactory results.

By G. CAMPBELL KOHLAR

NOT MANY YEARS AGO a boiler consisted of an arrangement of drums, tubes and headers which was set above a brick box containing some kind of device for burning fuel. The designer was concerned primarily with building a boiler to produce a modicum of steam without blowing itself, the operator and all concerned to kingdom come. Two hundred pounds was a terrific pressure, and a boiler operating at 150 per cent of rating was perilously near the danger point. As late as 1900, the most advanced boiler designs in common use were set from 2 to 4 feet above hand fired grates. Even with low firing rates, the furnaces were too small for complete combustion and veritable gales of excess air howled through none-too-tight settings. Efficiencies were low; operating costs were high; and the entire situation, viewed in the light of present accomplishments, was one of waste and complacent unprogressiveness.

This state of affairs, however, could not last long, and as the art of boiler manufacturing improved, it became evident that boilers could be pushed to much higher ratings without any danger. In order to obtain a greater capacity from a given boiler, it was necessary to burn much more fuel beneath it, and, what is more, this fuel had to be burned efficiently. The attention of the designers, therefore, was directed more and more strongly toward the brick box under the boiler, and the furnace was born.

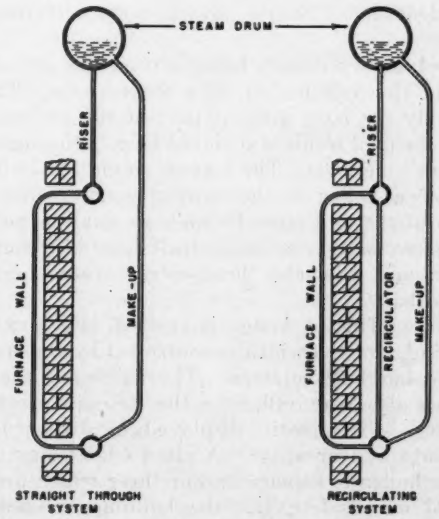
More Volume

Automatic fuel burning devices made their appearance and resulted in the Dutch oven type of furnace. The stoker was set outside of the boiler setting proper, thus leaving the whole volume under the boiler free for combustion and the mixing of the gases. Gradually, the idea dawned that it was not only possible, but practicable to increase the volume of the furnace by setting the boiler higher above the grates. This idea, which now seems to be so obvious that it might have occurred to any child, was really a tremendous step forward. By 1916, furnaces were larger and settings more nearly air-tight; firing rates increased and combustion improved; refractory arches were built over chain grate stokers; and the furnace was regarded as being almost as important as the boiler. Complacency had given way to aggressiveness.

The Water Wall Steps In

Today, the boiler and furnace as they were known as recently as 1935 have ceased to exist. They have coalesced into a single and individible unit, the modern high-pressure, high-duty steam generator. Three developments have made these giants of the power world possible: pulverized coal, water-cooled walls, and slag-tapping. Only with pulverized coal are firing rates of 50 t. per hr. of coal possible. Isolated examples of stokers which are burning more than 25 t. per hr. of fuel may be found, but they are the exceptions rather than the rule, and probably exist only because of some unusual condition. But even though it is possible to burn pulverized fuel at such a high rate, a refractory wall could not live under the severe punishment which this intense heat would impose upon it. Brickwork would melt or flux with the slag; it would spall from vitrification or slag penetration; it would permit adhesion or building out of slag, and tons of slag and clinker would frequently tumble into the furnace. The water-cooled wall was the solution to this problem.

Pulverized fuel and water cooled walls, therefore, have made the steam generator physically possible; slag-tapping has made it economically feasible. A slag-tap furnace has a number of advantages; it will burn cheap, low ash fusion coals; it eliminates the necessity for an ash hopper, thereby reducing the headroom required; it decreases labor costs for ash removal; it will give a greater ash recovery than any other type of furnace; and it provides an excellent target wall for downshot pulverized coal burners, thus improving combustion. True, it is possible to build a steam generator with a dry furnace, and such units have been built. But ordinarily, the cost of such unit and the expensive fuels



Two general types of water wall circulation systems. The first is the cheaper and is more often used on small units but the second has certain advantages, particularly with large units

to which they are limited prohibit their general use.

With this background of progress, the designer's approach to a problem is today quite different from what it was at the beginning of the century. His creations affect the balance sheets of thousands of industries throughout the world. Power plant operators are only human, and when a designer's problem affects their wallets, their interest in that problem is bound to be more than academic. Let us, then, look over the designer's shoulder as he considers his problem, and see what he has to offer the plant owner.

The procedure is fundamentally the same, no matter what the size of the unit, but because the great majority of boilers have capacities below 100,000 lb. per hr., only the smaller units will be discussed. A future article will consider the high-pressure steam generator.

The Start

The starting point in the design of any new unit is the prospective customer's specifications. These will include capacity, pressure at the superheater outlet, total steam temperature, feedwater temperature, kind of fuel, and a fuel analysis. If the fuel is to be coal, the following information is desirable: source of coal, fusing and liquid temperatures of the ash, and the grindability. Information regarding the boiler house also is necessary. Is a new building to be erected, or is an existing structure to be remodeled? Where are the building columns located? How high are the roof trusses? Is any particular type of boiler desired? The specifications should give the answers to these questions. The type of firing to be used, whether stoker, pulverized fuel, oil, etc., should also be stated. The designer, although he is guided by these conditions, does not always regard them as sacred. If, in his opinion, the purchaser has not made the best choice, he will submit one or more alternate designs, detailing at great length the advantages of his proposals. The final decision, of course, always rests with the purchaser.

Preliminary details being settled, the actual design of the unit begins with the furnace. This is probably the most difficult part of the problem because the final result is achieved largely through "cut and try" methods. The largest single factor in the cost of a boiler is the drums; consequently, the width of the unit must be made as small as possible consistent with reasonable draft losses through the boiler, and allowable heat release rates per foot of width.

Quite often, a boiler is erected in an existing building, and the width is controlled by the spacing of the building columns. The height of the roof trusses also may influence the design. Great ingenuity is frequently displayed in fitting a new unit into a given space. A plant owner may desire a new boiler to replace two or three which are outmoded or obsolete, but the building columns are placed in such manner that the new boiler cannot occupy any more space than one of the old ones. Considerable head-scratching ensues. The waste basket fills rapidly with discarded ideas; the air turns blue with naughty words; but the designer usually manages to "come up with the ball."

When the width has been determined, the remaining dimensions must be laid out. The kind of fuel and the manner in which it is to be fired are the important factors in proportioning the furnace. If the unit is to be stoker fired, the stoker will dictate the size of the furnace. Chain grate stokers are the most flexible. They are manufactured in a variety of widths and lengths, and the grate area can be proportioned to fit any furnace. Stokers of this type, however, usually require arches, which in turn require fairly high settings.

Underfeed stokers are slightly more difficult to fit into a given furnace scheme; often, the sidewalls are corbelled in order to accommodate them. But, all in all, the underfeed stoker does not present too much of a problem. The sprinkler, or spreader grate, stoker frequently causes trouble. The width of the stoker usually exceeds the length, especially in wide boilers, and the manufacturers of this equipment are apt to be fussy about the design of the furnace. They are justified in this attitude: for if the furnace is not properly proportioned, the coal will "pattern," and will not spread over the grates uniformly. Close co-operation between the boiler and the stoker manufacturers is necessary at all times; but, in the case of sprinkler stokers, it is imperative.

On the Drawing Board

Enough information is now available to lay out the furnace on the drafting board. When the design "looks right," the volume is checked, and the temperature of the gases entering the boiler tubes is calculated. This temperature is a valuable guide in deciding upon the type and distribution of water-cooled walls. Even though trouble caused by slag bridging across boiler tubes, or damaging the refractory upper walls is not particularly prevalent in the smaller and medium sized stoker-fired boiler, it is always desirable to keep the temperature of the gases entering the boiler tubes below the fusing temperature of the ash in the coal. Enough water-cooling must be supplied to accomplish this.

Water-cooling, however, is not absolutely essential to the satisfactory operation of a stoker-fired boiler, for many units of this type have run for years with all-refractory furnaces, but it is effective in materially reducing maintenance costs. The bridge-wall and the sidewalls immediately above the grate are subjected to the most damaging action of slag and clinker, and these sections of the furnace should be cooled. Refractory covered tubes or cast iron block covered tubes are generally employed for bridgewalls, and cast iron blocks on tubes that are inclined slightly from the horizontal are favored for sidewall cooling.

After the minimum water-cooled surface is decided upon, the furnace temperature is recalculated. If it is still too high, either more cooling surface is added, or a different type of surface is tried. Reducing the center to center spacing of bare tubes will increase their effectiveness. Tubes partially covered

with refractory are more effective than an equal number of bare tubes, and block covered tubes are most effective of all. The process of repeated trials continues until the optimum of satisfactory operation and initial cost is achieved.

Effects of the final design on the rest of the unit must now be investigated. In the large, high-pressure steam generators, these effects would be many and far-reaching; but in a unit of moderate size, only the superheater would be affected, and that, but slightly. The temperature of the gases entering the superheater must be kept within fairly narrow limits: if it is too high at the design rating, expensive alloy steels may have to be used for superheater elements; if it is too low, the required total temperature at the design rating cannot be obtained. The temperature entering the superheater may be adjusted by adding or removing tubes from the boiler bank before the superheater. It is seldom necessary to rearrange the furnace.

The Final Checkup

Furnaces in which fuel oil or natural gas is burned are set in the same manner as stoker-fired furnaces to the point at which the boiler width has been determined. The remaining dimensions are set by the number and type of burners, and the kind of fuel. The minimum number of burners that may be used on any particular unit is governed by the relation of the capacity of an individual burner to the required heat input to the unit, but the purchaser may desire more burners than the minimum in order to obtain greater flexibility. The size of the burners and the quantity of heat released by them determines the space between the burners, as well as the minimum distance from sidewalls, floor, and boiler tubes. It is these clearances which dictate the size of the furnace.

The same general conditions regarding the water-cooling of stoker-fired furnaces apply to oil and gas fired units. However, the cooling surfaces in these types of furnaces are usually 3¼ or 4 in. dia. tubes on from 6 to 9 in. centerlines. But whereas a stoker itself forms an admirable furnace floor, in the case of oil or gas firing the floor must be added. It is generally solid refractory, sometimes air-cooled, or else bare tubes on wide spacings, the tubes being covered with crushed firebrick.

Pulverized coal fired furnaces, although not unlike oil and gas burning types, require more attention to details. Water-cooling, even in the smallest installations, is vital. In such a furnace some walls should be kept hot while others must be cold; consequently, the kind and distribution of the water-cooled walls must be given careful consideration. The wall around the burners must be hot enough to maintain ignition; yet, a refractory wall will not stand up too well under these conditions except in the smaller units in which the heat input of the burners is not very high.

A burner wall probably will have some slight amount of water-cooling: perhaps bare tubes on wide spacing. The walls in the zones of intense combustion must be kept as cold as possible, so that the molten slag striking the surface will chill, and not adhere to the wall. These zones will have block covered, fin tube, or closely spaced bare tube walls. As the slag reaches the upper and cooler sections of the furnace, it assumes different characteristics, and the type of water-cooling must be changed in order to cope with a new kind of slag formation. Refractory covered tubes of some kind are generally used for this purpose.

Even the Floor Is Important

The floor of a pulverized coal furnace must be designed with care. Nearly all of the units of the size which we have been considering have dry ash removal systems, therefore, slag-tap floors will not be discussed. There are two type of dry furnace bottoms, hopper bottoms and rakeout floors, with an almost infinite number of varieties in each. All of these floors are cooled in some manner. Hoppers necessarily must be kept cold in order to prevent the slag from fusing into unwieldy masses. A screen of bare tubes, widely spaced, placed across the top of the hopper is effective. Hoppers constructed of block covered tubes also do a good job. Many units, especially the smaller ones, have flat floors from which the refuse is raked. Extreme care must be exercised in the design of this type of floor, for if the water in the floor tubes does not circulate properly, serious burnouts may occur.

One step more remains before our furnace is ready for action—circulation. A constant flow of water through the furnace cooling surfaces must be maintained at all times, so that the heat of combustion may be rapidly carried away. Unless adequate circulation is provided, steam will form in the walls faster than it can be removed. The steam will become superheated, and the temperature of the tube metal will rise to the point where tube failure occurs. Circulation is obtained in two ways: by pumping water through the walls, forced circulation; or by taking advantage of the fact that the density of water decreases as the temperature increases—thermo-syphonic action. Forced circulation, although it is rather popular in Europe, has not met with unqualified approval in this country, therefore, all circulation systems are thermo-syphonic.

The Final Step—Circulation

Waterwalls are connected into the circulation system of the boiler, and the drawing shows schematically the two methods used. In the straight through system, water is fed to the lower header, partly converted to steam in the furnace walls, and the whole mixture of steam and water is discharged into the drum. In the recirculating system, a number of pipes or tubes, known as recirculators, connect the upper and lower headers. The upper header in such a system acts, in a mild way, like a separating drum. The steam generated in the walls, together with a small quantity of water, is discharged upward into the drum; and the water flows down the recirculators into the lower header, there to repeat its cycle.

(Continued on page 52)

Condensate Temperature and Condenser Design

By J. O. STEPHENS
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In an article pH and Oxygen Control by Recirculation, on page 507 of the August 1939 issue, Bill Maddock raised a number of questions about mechanical deaeration. In connection with the use of the condenser as a deaerator he said in Footnote 2:

"It was called to the attention of the writer that some of the new condenser designs have actually had negative depression, meaning that the hot-well temperature was above that of the exhaust steam. One of the first laws of thermodynamics is to the effect that one body may not transfer heat to another body of higher temperature. Where would the heat come from that would raise the temperature of the condensate water higher than that of the steam from which it was condensed, unless the outlet cooling water was higher than the exhaust steam temperature?"

This so-called "refrigeration of condensate", while not serious, was a problem warranting some attention with the older condenser designs. Some 10 or 15 yr. ago a number of special reheating hot-wells were used and would probably have continued to play an important part if the widespread use of steam lanes had not accomplished the same result with plain hot-wells. The seeming paradox of condensate temperatures higher than the saturation temperature of the exhaust steam can be explained by the difficulty of accurately measuring condenser pressures and the fact that these are static pressures with no allowance for the rather high steam velocities at the neck of the condenser. By recovering some of this velocity energy the static pressure at the lower part of the condenser can be raised slightly. The anomaly of flow from a lower to a higher pressure is the same as in a Venturi tube when the static pressure at the throat is considerably lower than it is beyond the diverging discharge section where a large part of the velocity energy has been reconverted back to pressure.

Back in the 1920's when deaeration became important, condensers were used effectively for this purpose by introducing the make-up there. The practice is still common, both in stations using all closed heaters (see Fig. 1, p. 166 March 1938, Bryce E. Morrow Plant) and stations using deaerating heaters (see Fig. 9, p. 566, September 1939, Winnetka Electric Plant). With a tight system and steam sealed storage tanks, all closed heaters can be used successfully and this is standard practice with a number of companies. One large engineering company that formerly used this arrangement and depended entirely on the condenser for deaeration now uses deaerating heaters as a result of experience during the depression. The closed system worked satisfactorily during continuous operation, but when units were shut down over week ends and the system filled up with air, several hours were required to completely eliminate air and oxygen from the system. They now include a deaerating heater in the heat balance primarily to handle the air overload during frequent starting up periods.

These points should have been covered by an Editor's Note in the original article, a responsibility which we gracefully sidestep with the excuse that if we had not forgotten to do so Mr. Stephens would not have sent in a more complete discussion of condensate temperature as affected by condenser design and the effect of better condenser design on surface requirements. In connection with this last we asked Mr. Stephens:

"In connection with your Fig. 2, we wonder if you have made any attempt to divide the improvement in condenser performance on a square foot basis between the improvement due to condenser performance and the reduction in surface made possible by larger quantities of extracted steam. The decrease in surface per square foot per kilowatt reflects both of these conditions. We are rather of the opinion that the increase, or rather decrease, in surface per kilowatt since about 1924 or 1926 has been due largely to the increased quantities of steam extracted.

"According to your curve the 1924 average value would be about 1.4 whereas the 1937 value is slightly over 1.0. If we assume that 25 per cent is the average quantity of steam extracted in a modern machine, the reduction in steam flow to the condenser per kilowatt just about accounts for this difference in surface."

His reply was:

"Regarding Figs. 2 and 3, you are entirely correct that extracted steam for feedwater heating has influenced installed condenser cooling surface. The curve of square feet of condensing surface per kilowatt hour was first intended to show a trend in absolute condenser efficiency, but it was soon realized that this was an almost impossible undertaking, not only because of extracted steam, but also of cooling water conditions. The latter factor alone could cause as much as 50 per cent variation in condenser installations, so the curve resulted in one showing a trend in installed cooling surface rather than an absolute measurement of improved efficiency.

"The curve, however, reflects very distinctly that installed condenser capacity is not likely to change very markedly with only steam for feedwater heating being extracted. It should also prove helpful in making a rough estimate in size of a single-pass or double-pass condenser required for a prescribed turbine."

STEAM LANING has become popular in modern condenser design because it allows the steam to flow directly down through the condenser to the hot well where it is reversed and returned to each of the tube banks, as shown in Fig. 1. This has the effect of increasing the pressure in the lower half of the condenser due to impact of the steam. The steam being saturated, this increase in pressure naturally results in an increase in temperature which gives a better condenser efficiency, due to increased temperature of the condensate and to increased mean temperature difference in the lower part of the condenser. With the usual means of measuring the pressure in the condenser neck, it is entirely possible for the temperature of the condensate to be even higher than the saturation temperature corresponding to the pressure in the condenser neck.

Fig. 1. Diagram showing how steam laning of the condenser affects the steam flow and condensate temperature

Some call this "superheating of the condensate," but if the true velocity head of the steam was added to the static pressure, the corresponding saturation temperature would be slightly higher than the condensate temperature. Since the steam velocity varies over the cross-section of the condenser neck, it is difficult, if not impossible, to measure the true velocity head, therefore the average of several static pressures is generally used in condenser tests. From tests (Van Hengal, A.S.M.E. Transactions Vol. 58, p. 627) a mean temperature difference of 18 deg. F. was noted at the top of one condenser and 24 deg. F. at the bottom, showing an available 37 per cent increase in heat transfer in the lower part of the condenser. This total increase in heat transfer is not found in the actual condenser, because the lower tubes have a higher resistance to heat transfer due to the condensate from the upper tubes flowing over them. For best design regarding constant heat flow throughout the condenser, the increased resistance to heat transfer, as the steam-air travels down through the condenser, should balance the increase in mean temperature difference in the lower part.

Opening paths for the steam to flow back into the center of the tube banks on either side of the condenser gives a greater mean temperature difference in the center of the tube banks and consequently increases their heat absorbing capacity also. This increase in mean temperature difference will be partially offset by the increased resistance to heat transfer, but for overall operation it has been found that the efficiency of old condensers can, in many instances, be improved by removing some of the tubes, providing a better flow in the steam-air circuit.

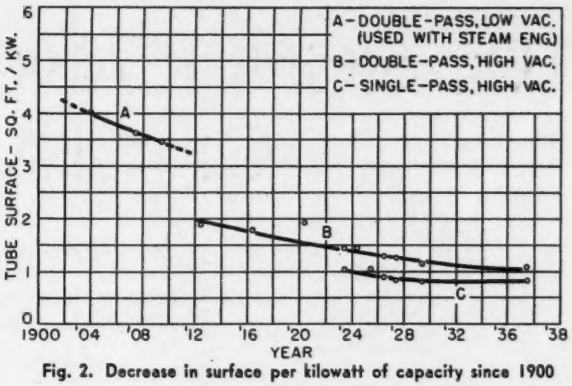
A-DOUBLE-PASS, LOW VAC. (USED WITH STEAM ENG.)
B-DOUBLE-PASS, HIGH VAC.
C-SINGLE-PASS, HIGH VAC.
TUBE SURFACE-SQ. FT. / KW.
YEAR
1900 '04 '08 '12 '16 '20 '24 '28 '32 '36 '38
0 1 2 3 4 5 6
A
B
C

Fig. 2. Decrease in surface per kilowatt of capacity since 1900

This general trend of putting steam lanes in the tube banks began in the early 1920's and a good measure of the general improvement in reduction of tube area per unit heat rate can be shown by plotting the average square feet of condenser surface per kilowatt against time as in Fig. 2. The change of circulating water velocity and the amount of circulating water is shown in Fig. 3 for the same period of time.

It must be kept in mind when observing these curves that the points plotted are, as near as possible, the average values of the condenser tube surface installed per kilowatt hour output of the unit. In the early stages of condenser development, variations as high as 200-300 per cent occurred, so it would be absurd to say that an absolute value could be used prior to 1920. The last point on curves B and C, Fig. 2, are averages for all the condensers installed in that year by the larger manufacturers.

This also applied to Fig. 3. In addition, the temperature of the cooling water used will usually have a greater effect upon the amount of cooling water required than it will upon the increase of surface. This reason probably accounts for the wide variation in the points plotted. No accurate data were available as to the actual velocity used in a condenser operating under full load, and it is not possible to calculate this value for actual operating conditions, because few plants have an accurate method of measuring the amount of water circulating. The curve shown is based entirely upon statements by condenser manufacturers; the last point being the velocity used in the Port Washington Power Station.

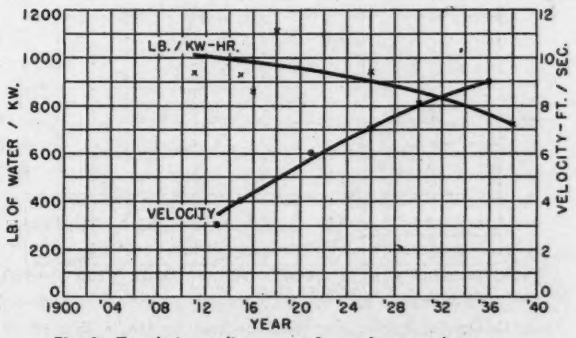

Fig. 3. Trends in cooling water for surface condensers

THE SIGNIFICANCE OF GLASS INSULATION

By GRAHAM LEE MOSES

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GLASS INSULATION has developed very rapidly in recent months and is being studied for application to all fields of rotating apparatus and some types of stationary equipment. At the present time most engineering effort is being concentrated on the application of glass insulation in those cases where high temperature, vibration and excessive moisture conditions are encountered.

Much has been said and written concerning the peculiar characteristics of glass textiles which are alleged to make them satisfactory insulating materials. However, most of this has been in generalities or abstractions with the assumption that the layman and user, whether he be repairman, operating engineer, or design engineer, understands exactly why these characteristics are desirable. It, therefore, seems timely to pause and analyze these features and correlate them to actual operating conditions.

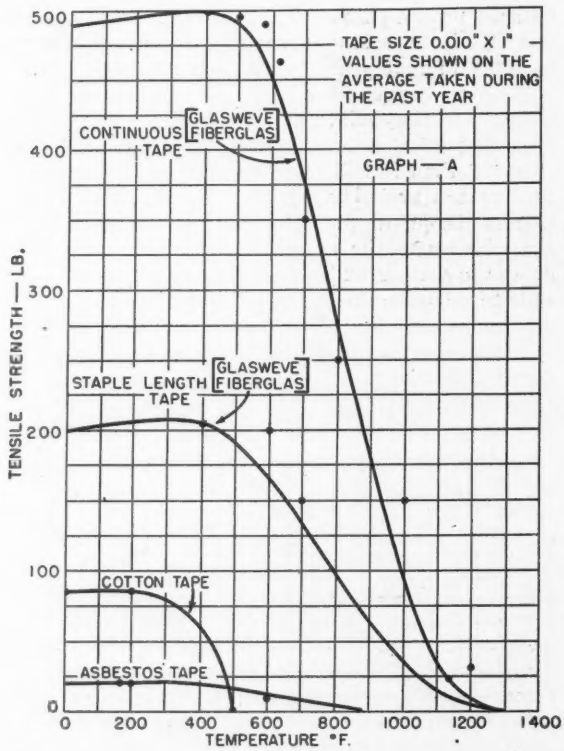

Fig. 1. Curves showing the effect of heat on tensile strength of fibrous electrical insulating materials

When this is done the real significance of the development of glass insulating fabrics will be more apparent. From such a better understanding of the true character of this material it should be possible to use it where it is best suited and avoid using it where no real advantage is derived or where its limitations may make it unsatisfactory.

It has been clearly demonstrated that glass fabrics are stronger than conventional insulating materials such as cotton, silk and asbestos. This relation not only exists at normal temperatures but is more pronounced at elevated temperatures as clearly illustrated in Fig. 1. At temperatures around 200 deg. C. (492 deg. F.) all organic material deteriorates very rapidly and soon loses practically all its mechanical strength. Even asbestos fabrics (which usually include some organic material) slowly lose their strength at this temperature but there is no evidence to indicate any loss of mechanical strength in glass fabrics at this temperature. The life of insulation is measured by the time required for it to lose its mechanical strength. This is a slow process on organic fabrics at normal temperatures which is accelerated by higher temperatures. Glass insulation neither oxidizes nor loses its mechanical strength at operating temperatures now permissible in electric machinery and therefore can be expected to have an excellent life span.

The fact that glass does not deteriorate at extremely high temperatures is generally classed as a separate characteristic. However, this is so closely tied in with its relative mechanical strength as discussed in the preceding paragraph that they are difficult to separate. This is due to the fact that it is exposure to high temperatures which causes conventional materials to deteriorate. Actually glass insulation does withstand temperatures so far in excess of other insulating materials that for emphasis its resistance to high temperatures should be classed as a separate feature. Glass fabrics do not take a permanent set (become brittle) until they are heated above 700 deg. C. (1292 deg. F.) and do not soften until heated to about 800 deg. C. (1472 deg. F.). This is so far above any operating temperature ever considered for motors, generators or control that a tremendous factor of safety remains.

The fact that glass fabrics are "non-hygroscopic" requires considerable analysis. First it is necessary to visualize the true nature of glass textiles. No one will dispute the fact that a glass plate or glass ball

Figs. 2 & 3. Glass tape used for insulating coils in electrical equipment. Views showing coils for electric generating and motor equipment wound with glass insulating tape

of finite dimensions does not absorb moisture. However, it is difficult to comprehend that glass fabrics are made up of almost infinitesimal glass rods which do not absorb moisture into themselves. Nevertheless this is the case as the so-called glass fibers are not "thirsty" in the sense that cotton, wool, silk and asbestos are, as all these latter fibers do absorb moisture within themselves. Incidentally the absorption and subsequent giving off of this moisture accelerates deterioration of the fibers.

Even having proven that the glass fibers are themselves "non-hygroscopic" it is then necessary to demonstrate whether this is as important as the penetration of moisture between the fibers for it is well known that no treatment can completely prevent penetration of moisture. The results of a series of tests under high humidity are shown in Fig. 4. From this it is apparent that glass insulation maintains a higher insulation resistance than asbestos when exposed to high humidity and when both are treated in the same varnish. Furthermore an untreated glass coil ultimately stabilizes at an insulation resistance above that of the treated asbestos coil. The conclusion drawn from this is that the absorption of moisture by the asbestos fibers, even when treated, is more detrimental to the true insulating characteristic than the collection of moisture between the fibers of untreated glass insulation. It is therefore apparent that the "non-hygroscopic" or "non-thirsty" characteristic of glass fibers is of great importance.

The ability of all fabrics to withstand voltage strains is low where the pores are not sealed with varnish or other impregnant. In fact when the untreated materials are clean and dry, the dielectric breakdown will be approximately that of air (100

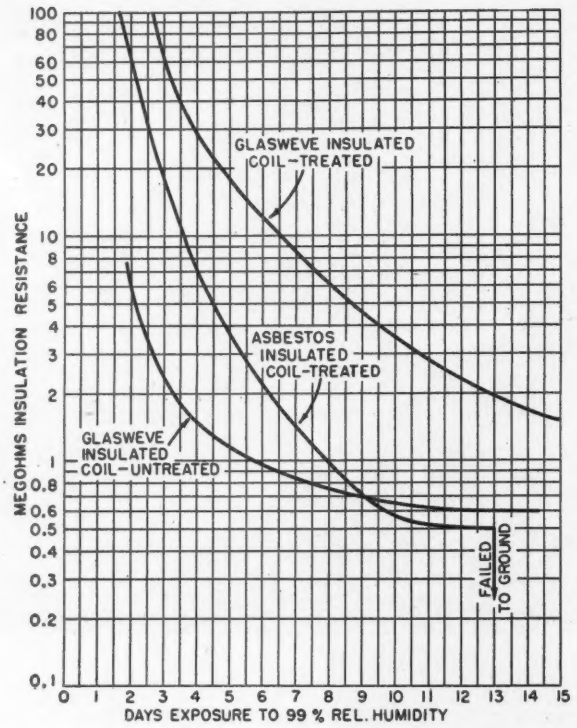

Fig. 4. Curve showing effect of exposure to 99 per cent relative humidity on coils impregnated with solventless varnish as compared to no treatment

volts per mil). Where impurities are present in the material, such as in inferior grades of asbestos, this value is reduced. With glass fabrics the material is controllable to maintain a uniform product and breakdown voltage. The presence of moisture reduces the dielectric breakdown voltage of glass insulation less than it does other fabrics due to the non-hygroscopic character of the glass fibers as discussed earlier. Where fabrics are treated with varnish, or other impregnant, their dielectric breakdown voltage is largely dependent upon the characteristics of the impregnant. However, again in this instance glass fabrics are less affected by moisture than conventional fabrics made from "thirsty" fibers. Where glass fabrics are to be exposed to high temperatures it is undesirable to rely upon the dielectric strength of the treatment as this is apt to deteriorate. In its present fibrous form glass insulation is not comparable to mica in dielectric strength.

The resistance of glass insulation to attack by acids, oils, corrosive vapors and vermin is of obvious advantage only where such hazards exist. However, it is an important factor of safety that is thrown in for good measure wherever this material is used.

Glass fabrics have greater thermal conductivity than conventional insulating materials. This means that for a given flow of heat the temperature difference through the insulation is less. The net saving in temperature difference is reflected in lower internal temperatures.

The excellent appearance of glass fabrics, particularly those woven of continuous fibers, results in better appearance of individual coils and complete machinery as this material takes a fine finish when treated with most varnishes.

No discussion of glass insulation is complete which does not bring out its disadvantages and undesirable characteristics as well as its good points. One of its very desirable features, its smooth silky finish, works against it if used in the same manner as conventional tapes. When snubbed in tension the weft slips on the warp. This is more prevalent in the thinner tapes and may be corrected by improvements in weaving. Until such a time this tendency can be minimized by preheating the tape in a solventless varnish and only partially curing.

Perhaps the greatest limitation to the use of glass insulation is that its resistance to shearing against sharp edges is not high. Although most of the characteristics associated with glass have been modified, it is still fundamentally glass and its inherent brittleness is evidenced in this manner. This places a responsibility on the designer and user to avoid sharp edges. When this is done, it can be used without fear.

When the good and bad characteristics of glass insulation are weighed there can be but one conclusion; namely, it is a valuable addition to the family of insulating materials. It must be used with judgment and not applied indiscriminately. If this is done there can be no doubt but that it will become an important factor in the electrical industry.

It's Your Furnace

Continued from Page 47

A detailed discussion of circulating systems is beyond the scope of this article, and it will be sufficient to note that the system used depends largely upon the economics of the unit under consideration. The straight through system is cheaper than, and just as effective as the recirculating system on small units; on a medium sized installation, the recirculating system has definite advantages; but on the really big steam generators, the general practice is to revert to the straight through system. It is impossible to propound any rule for the selection of a circulation system other than this: Listen carefully to what the designer has to say, and then make your own decisions.

This article has attempted to show the operating engineer and the power plant owner what the designer's problem is from the operator's point of view. It is hoped that an increased understanding of these problems will bring the builder and the purchaser into a closer co-operation which will result in installations that are even more adaptable than those now being built. A power plant operator wants a plant that will increase profits; and, if besides doing this, the plant is a showplace and a model of the latest practice, he is a happy man indeed. In fact, there is only one man who is happier —the man who designed the job.

Customer Relations

Serve customers with promptness and courtesy; tell with frankness operating costs and reasons for service charges.

WITH THE long and intensive study that has been given this question by the public utilities, little need appears for suggestions as to purpose or method of cultivating good customer relations. With the present tendency toward government competition with and absorption of utilities, it is worth while, however, to review possibilities and results to be sought.

Government ownership and operation are, of course, in direct conflict with the principle of individual enterprise. The fact that utilities supply a product widely used does not alter the situation. For in no case—transportation, communication, light, heat or power—does a utility furnish service that cannot be replaced by other facilities. That individual enterprise has evolved services which the public find more satisfactory than the other facilities is a tribute to the activity of the privately owned utilities and should warrant encouraging them to continue the good work. On one point only is there a sounder basis for government interference with utilities than with the making of shirts, shoes or stoves. That is the fact that a utility, to render the most economical service, needs to operate as a monopoly in any given area. This premises government permission to operate a monopoly, such as lies in a certificate of necessity or convenience before a new utility is given leave to go ahead. That the economy of such a monopoly is recognized is evidenced by the effort to combine railroads into a few large systems, and electric generation and transmission into integrated networks for interchange of power. Duplicated generating plants and paralleled transmission systems are so expensive and so economically unsound that they are hardly considered, except where there is some ulterior motive other than economy of furnishing services.

With the establishment of a monopoly there is always possibility of exploitation and, unfortunately, spite of the uniform good record of utilities in working for the best interests of the public and passing on savings effected in the form of lowered rates to customers, there have been enough cases of inconsiderate management to give advocates of public ownership some basis for their propaganda. Against such propaganda the effective activity is frankness in stating and having verified by independent auditing the facts as to operation of utilities, costs, services rendered and charges for such services. To have such data accepted by the public, those served must have a friendly feeling toward utility organizations; and the most intimate touch with those organizations is through the employes who contact the public, meter readers, sales organization, service men, employes in local offices. That is why it is well that much effort be expended to have those contacts cordial and friendly.

Prompt attention to complaints and adjustment of differences, trying to get the customer's point of view, some flexibility as to rules on discounts and, above all, a simple system of charges that customers can easily understand and check will do much to create the feeling that a utility desires and really intends to serve.

Emphasis on how the customer can effect savings by use of separate power lines, off-peak rates, bettered power factor, more effective lighting arrangement and fixtures is effective in creating a friendly atmosphere. Abstruse discussion on the equity of a complicated rate structure will usually only confuse the issue and it is easy for the customer to accept somebody's statement that his bill is 20 per cent higher than it would be if he had the rate existing in the lowest community in the country, regardless of the difference in conditions and cost of generation between that community and the one where he lives. If he feels that his interests are being given friendly attention he will be more ready to take into account the factors that make cost of serving him greater than that under other conditions.

As an example, one power company has motorcycle trouble men at various points on its system. If a customer reports trouble, a service man appears promptly on the scene, cleans his feet, removes his hat, remedies the difficulty and reports "all clear" to the office from an outside phone. Then the office operator calls the customer, asks if the trouble has been satisfactorily remedied and everything is all right, and requests to be notified if there is further trouble or any other difficulty. Incidentally, the trouble man not only fixes the reported trouble but asks permission to inspect the rest of the electric system to catch any possible trouble which might develop or to suggest such improvements as might be desirable for convenience and economy.

Publicizing the services rendered is important. Readiness to serve loses its value unless the public knows about it. And one of the most effective means is the news story of service rendered, especially if it can contain live human interest. Larger organizations are alive to this, but it is no less important to the utility in a smaller community.

A half column about saving of life by an inhalator squad is good, but a ten-line item about saving the family dinner for a housewife may get more interested readers. Frequent small items are better than longer, less frequent articles. And don't be peeved if the editor doesn't use them all. He will take those which seem to him to have reader interest. And any advertising you may be doing will not affect his judgment, if he is a conscientious editor.

Above all, publicity items may be sincere, a record of facts. There is enough of real news interest about employes, activities, services rendered, improvements and services available to give all the items that the press can use. A made up or touched up story will seldom get past an editor, and will prejudice him against other material received from the same source.

Part I. Although widespread in its occurrence and almost universally present in natural waters, silica did not offer a serious boiler water treatment problem until modern high pressures came into practice. This first article of the series of two deals with the occurrence of silica in nature, its action in low and high-pressure steam boilers and a comment on common water treating practice. Part II will describe a method of treatment designed specially to remove silica.

Silica in Boiler Feedwater

By

WILLIAM F. PETERS, JR.* and DR. W. D. TURNER†

SILICA consists of the two elements silicon and oxygen combined in a substance having the composition and noted by the formula SiO_2. It usually occurs in nature in either this form, or in combination with other elements, as silicates. Next to oxygen, silicon is the second most abundant element in the earth's crust.[1]

Occurrence

Siliceous matter may occur in nature in the solid form in various sizes of aggregate. In larger aggregates it occurs chiefly as sand, mud and clay deposits, quartz and siliceous ore deposits. If the grain size is small enough, we reach a point where it becomes silt. It then occurs as a suspension such as is found in rivers after a storm. This phase need not be considered seriously in water treatment, except where abnormal conditions occur, as in the case of the lower Mississippi River, or where there are older types of boiler plants that use raw unfiltered water inasmuch as most modern plants use filtered water. A method of treatment, however, must be provided for such cases.

Silica may also occur in the form of soluble silicate, the most notable of which is sodium silicate. Small amounts of silica are dissolved by alkaline waters. Hot alkaline waters dissolve much larger amounts than cold waters. Thus, alkaline water flowing over sand formations, or hot water flowing through sand filters will form soluble silicates. Water from wells often has more silica in it than surface water, most probably due to the effects of pressure, alkalinity, and filtration through underground minerals. Soluble salts may also consist of silicates of calcium and magnesium. Due to the solubility of silica in alkali, most silica salts probably exist as sodium silicates of varying compositions, such as orthosilicate, Na_4SiO_4; metasilicate, Na_2SiO_3; diorthosilicate, $Na_6Si_2O_7$; dimetasilicate, $Na_2Si_2O_5$; and trisilicate, $Na_4Si_3O_8$; or the corresponding compounds of other alkali-metals, as these are the only ones soluble in water.[2] Alkali sodium salts in water, particularly in soft water, treated or untreated, increase the alkalinity and aid in the dissolving of silica.

In addition to the above, silica may exist also as either a crystalloid or a colloid dispersion. The crystalloid, as a rule, can be easily treated and removed by chemicals. The colloidal silica on the other hand, of which soluble silicic acid is typical[3], is less amenable to treatment and most difficult to remove, and is the most prevalent form of silica in water. The colloid, due to its nature, cannot be filtered out by ordinary means. When water passes through fields of decayed hay, straw, leaves, etc., it acquires a tannin which not only holds colloidal silica in solution, but also the crystalloid in suspension, thereby increasing further the total silica which may be retained.

Still another source of silica is the diatomaceae which are "characterized by their utilization of silica to form siliceous cell walls. At times of their abundant growth silica is removed from the water in appreciable amounts, and this is followed by an increase in the silica content of the lower waters, due to the precipitation of the dead cells and the solvent action of the water or its constituents upon the silica. The maximum silica content in the lower stagnant waters occurs just prior to the fall overturn."[4] Analysis of the Asterionella shows almost 50 per cent silica on the dry basis.[5]

Action of Silica in Low-Pressure Boilers

Practically every power plant uses a feedwater treatment for the prevention of boiler scale. Stress is laid upon the removal of the calcium and magnesium salts. Yet upon analysis of the slight scale that may be formed after treatment, silica has been

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found to the extent of from 5 to 50 per cent. Even in Oregon and Washington, with their naturally soft waters, scales are often formed, and when formed may contain up to 60 per cent of silica.

The question is then asked, "Where does this silica come from, and how can it be removed?" To quote one text book, [6] "Silica is usually found only in very small proportion, and is not of much importance except that it slightly increases the quantity of scale. It may, however, when most other scale forming salts have been removed by softening, produce a small quantity of very hard scale." This scale sometimes is almost impossible to remove. Again, [7] "Except in those cases where silicates are encountered . . . the problem of the elimination of scale is practically nonexistent in the modern power plant." This later statement is correct except that in practically every raw water used for boiler feedwater make-up, there is silica. So long as this remains in the water, there is always latent the danger of silica scale, caustic embrittlement, or carry-over.

Another source of silica is that found in the so-called boiler compounds, of which silicate of soda is the most common. "Silicate of soda may accelerate instead of inhibit these deposits. When large amounts of silica are deposited, the scale formed is very hard and difficult to remove. These silicates when deposited within the boiler cause much trouble, since they are of very dense crystalline structure, adhering tenaciously to tubes or on sheets of the boiler."[8]

Most of the modern methods now used are for the elimination of the calcium factor in scale formation, but are not designed to remove the most dangerous factor, silica. Now these methods are designed to remove the scaling factor, but as a rule create a fairly high pH; that is, usually over 11, except in the most modern practice. Silica is practically insoluble at a pH below 6.2, above that it has a tendency to go into solution. At about 10.5 it forms $Na_2O,2SiO_2$; at about 12.1 it forms Na_2O,SiO_2; and at a pH of 12.7 it forms $2Na_2O,SiO_2$; all soluble silicates. Thus, if silica is present in precipitated form at pH of 10.5[9] it is liable to redissolve in alkaline solutions at a point above pH 11.5[10]. This fact may help to keep boiler tubes clean but is likely to be very detrimental to turbine blades.

High-Pressure Effect

With the advent in the last ten years of the higher-pressure steam boilers, a new type of scale has appeared, and this scale is found to be extremely high in silica content. It is most often glass-like in appearance. In addition to this, at these high pressures, silica has often carried over on to the turbine blades and has produced a glass-like coating of silica that is extremely difficult to remove and analyzes about 90 per cent SiO_2. In the older types of low-pressure boilers, the silica in scale seldom rose over 30 per cent, while in the newer high-pressure type of boiler it reaches 60 per cent. The main idea up to now, for the treatment of high-pressure feedwater, has been similar to that for low pressures, i.e., the removal of the scale forming solids, calcium and magnesium. The water used in these boilers was either treated internally in the boiler, or externally in some form of softener to remove as much as possible of the scale forming materials, calcium and magnesium. Such water was considered of excellent quality when it was found to be soft by the soap test, or by some method or chart devised by the equipment manufacturer. Even after removal of all possible hardness, however, scale formed in some cases, since no attention was paid to the smaller constituent of the water, silica.

With the higher pressures, scale formation is much more serious than at lower pressures, for a very thin, dense scale often leads to tube rupture. Again, in high-pressure boilers, if as large amounts of suspended solids are carried in them as in low-pressure boilers, the solids are liable to deposit on the tubes, as the concentration of the solids becomes too great for the pressure. The thermal effect of these sludges, and the insulating action of the silica scale, greatly increase the temperature differential between inside and outside of the tubes. This is further aided by the fact that higher pressures require increased tube thickness, increasing still further the temperature of the outer surface of the tubes. Thus a very small amount of scale vastly decreases the cooling action of water, which at higher pressures is not so cool, and allows the tube more quickly to approach the fusion point of the steel. As soon as this point is reached, a rupture occurs. A number of engineers have often wondered at this, because the silica scale coating is often very thin, hardly ever more than a sixty-fourth of an inch in thickness. It is the density of this scale, which appears very much like enamel on a stove, that causes the trouble.

The silicates found in high-pressure boiler scales seem to have more silica than is necessary to form the meta silicates. Some investigators feel that these scales contain free silica. A number of these scales when analyzed have calcium usually in the form of calcium carbonate, which, of itself, is supposed to be non-scale forming. It is evident that the silica must then be either in the nature of a binding agent, cementing carbonate sludge into dense scale, or it must form some complex silicate involving calcium. As most of this takes place in boiler waters with a pH of usually 11 or over, it is reasonable to suppose that the salt-forming action of silicic acid asserts itself as it is known to do in alkaline solutions. It is probable that some complex calcium salt of a cement-like nature is formed.

This formation is undoubtedly favored by the high heat and pressure. As sludge density increases, it will tend to be deposited on the tubes. When first deposited it may be easily removable, but as the heat of the tube increases, it will reach a point when the silica will glass over, making a dense scale. It is the writer's belief that it is the action of silicic acid in alkaline solutions that is responsible both for dense scale formation and caustic embrittlement. Even the naturally soft waters of Oregon, Washington, [11] and New England have scale troubles at high pressures.

Another effect of silica in water, is caustic em-

brittlement. Much has been written regarding this, so we will only touch upon it briefly. Originally caustic embrittlement was thought to be caused by caustic soda, but checks made upon the original work have shown that it is due to silica. Research work is still being carried on. The crux seems to be that silica is the catalyst. [12] There is enough silica present in all waters to act in this catalystic capacity. This danger can be overcome if enough of the silica is removed from the boiler.

Still another effect of the silica, is one of carryover. In all samples of carryover examined, there has been silica present. In the worst cases it occurs as a glass-like deposit on the steam turbine blades. There is less liability of carryover in higher-pressure boilers, due to the lack of tendency to foam in them, than the lower-pressure boilers. This is due to the steam bubbles being smaller, resulting in less violent ebulition. The product most commonly found in carryover, however, is analcite, a zeolite, a sodium aluminum silicate. The product of carryover is different in nature and character from the scale or sludge found in the boilers. This is due in part to the total lower salt concentrations maintained in high-pressure boilers as compared to those of lower pressures. Here again if you remove silica, you remove the danger of carryover.

Common Treating Practice

As indicated above, feedwater that can be successfully used in low-pressure plants, as a rule, cannot meet with the same success in high-pressure plants. For the high-pressure plant there are a number of common methods of pre-softening the boiler feedwater externally. The zeolite or base exchange method is still used. Hot and cold lime and soda softeners are also used. In addition to these, there is a new zeolite process using acid regeneration, the use of which is gradually spreading. There are also several compounds for internal treatment including phosphates, aluminates, iron coagulants, and organic agents. No one of these processes, however, is purposely designed to eliminate silica. Let us consider these methods.

The zeolite softener reduces the hardness to approximately zero, usually within 1 or 2 ppm., but it does not remove silica. Should by any chance, hot water, or water with low pH be allowed to go through it, additional silica will enter the system, due to the zeolite going into solution. If the water is highly bicarbonate, as in the states of Ohio, Indiana and Illinois, acid after treatment must be used to reduce the alkalinity, and release carbon dioxide, and aeration must follow. If this is not done, the sodium bicarbonate water produced by the zeolite will eventually break down in the boiler to sodium hydrate and a rapid increase in the boiler water alkalinity follows. This increases the quantity of silica that may be carried in solution, and more probably aids the action causing scale formation, caustic embrittlement and carryover. Also the carbon dioxide given off goes over in the steam, and is liable to cause return line corrosion.

The cold lime and soda process may soften the water to within 10 to 20 ppm., of zero hardness, but in order to do this, about 40 ppm. or more of alkalinity must be in excess. In turn the effluent has a pH of above 9.5. This high pH is enough to prevent the elimination of silica and is liable to form a sodium silicate which is soluble. A coagulant consisting of alum or an aluminate or a form of iron is often added, but unless the time element is long, it does not seem to reduce the silica materially, though it will reduce the hardness.

The hot process lime and soda softener as is usually operated, will remove some silica in varying amounts up to a maximum of 75 per cent, [13] but on account of the pH of the effluent it is not effective, similar to the action in the cold process softener. The effluent carries a definite amount of calcium and silica into the boiler forming calcium silicate scale. If in either the hot or cold process softeners, the effluent is filtered through a sand filter, additional silica will go into solution due to the high pH. Magnetite or hard coal filters may be used to obviate this difficulty.

The acid zeolites or these that are regenerated with acid, act similarly to the zeolite softeners already mentioned, except that they have a lower pH due to the hydrogen radical replacing the soda. Also they are not so likely to dissolve silica as in the case of the regular type of zeolite.

Alumina coagulants are used in several forms. The most commonly used are alum and aluminum sulphate, and in recent years, particularly for boiler water conditioning, sodium aluminate has been introduced. Alumina is an aid to silica removal, but for high pressures, it is not the best to be used. It does its work effectively only if the pH of the water is kept around 8, and above the pH of 8 the alumina redissolves. At this pH, it will form an excellent coagulant due to its spongelike coagulating power, and will probably unite either with the calcium to form calcium aluminate or calcium aluminum silicate. As all boiler waters are above a pH of 8, soluble alumina is formed. This soluble alumina in boilers may form sodium aluminum silicate (analcite), which is liable to carry over and clog superheater tubes, causing blisters, etc. The main difficulty is the control of the aluminum salts.

Iron coagulants are also used, the most common of which is ferrous sulphate. The disadvantage of this salt is that additional chemical is needed to overcome the increased acidity it causes. This dissolved salt increases the blowdown requirements of the boiler. Ferric chloride is being tried out and while it is new in the field has considerable in its favor. Ferric hydroxide, another type of iron coagulant, also avoids these disadvantages. Iron coagulants offer the advantage of coagulating over a wider pH range than alumina, viz., up to pH 12, making them desirable coagulants for both external water softeners and internal boiler water treatment. As most boiler feedwaters are alkaline with a pH of over 9.6 but less than 12.0, the question of the dissolving point or iron does not enter in. Due to its wide range of coagulation it can be used for high-pressure work. It may form an iron sodium silicate, but due to its weight

there is less danger of its carry over, as in the case of the sodium aluminum silicate similarly formed.

As internal treatments, phosphates are mostly used, but while there are several kinds, none is specifically marked for its silica removal value. Metaphosphate reverts instantaneously to orthophosphate under pressure of 5 lb. or over, and pyrophosphate requires 90 lb. pressure[14]. An excess of from 50 to 100 ppm. of phosphate must be maintained at all times in boiler water to prevent the reversion of the tricalcium phosphate which is non-scale forming to the di-calcium phosphate which is scale forming. The chief fault of the phosphate is that at modern boiler pressures and alkalinities, the phosphate is so finely dispersed that it carries over in the steam too readily. If the amount of silica in the boiler water is materially reduced, this fault is lessened and phosphate does not carry over as easily.

There are a number of materials that can be used only for internal boiler water treatment. Many internal agents are of an organic nature. The phosphates have been mentioned, as well as soda ash and other chemicals, and as stated these have no silica removal properties. Most of the organic agents are fed directly into the boilers because some have been found to be oxygen removing agents. In this way they do not absorb oxygen in the feedwater heater. Another point limiting their effectiveness, is that at high temperature they tend to break down into their elements, forming carbon dioxide, etc. Each material has a critical temperature at which it disintegrates.

Cutch and various other bark extracts are used, and seem to have a quieting tendency upon boiler waters. A great deal is claimed for them, and they do have their merit. Some forms have good silica removal properties and others do not. Lignum, a waste product in pulp making, if purified enough can be used as a silica removal agent. Certain Far Eastern gums have silica-removing properties. The alginates appear to have greater calcium-removing properties than silica-removing, and most of these organic materials are not rated on their silica removal property, but their calcium carbonate equivalent. Another form of material used is the class known as glucosates. These appear to yield results, if the proper care is maintained so as to have them react with silica. Forms of starch and sugar are also used, but not as silica removal agents to any great extent.

(To be concluded.)

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The Hotel Power Plant

Continued from Page 44

basis of operating costs alone the power, light and heat produced by the power plant is less than $55 per year but, of course, to this must be added the fixed charges and such other expenses inherent in the existence of such a power plant.

This plant will return its full cost through its savings in less than four years' operating time. The plant was installed with no initial cash outlay and is liquidating itself out of the savings it produces. The total cost of the power plant is considerably less than 3 per cent of the value of the total property.

Conclusion

The foregoing figures indicate that the modern hotel can in many cases make its own power at a savings. This is especially true where the hotel would have to operate and maintain a steam plant in any event whether power was purchased or not.

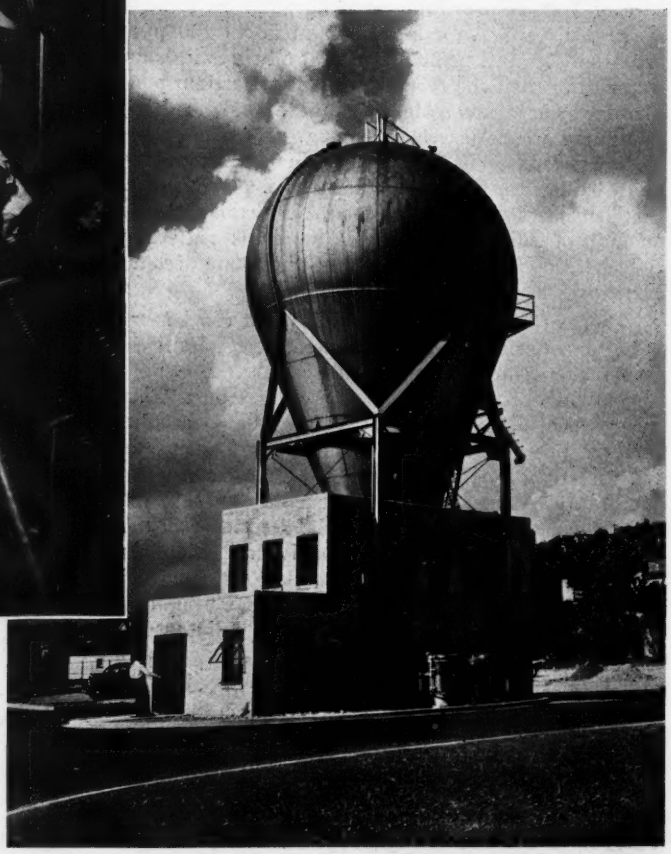
In all this there is no implication that utility power costs are excessive or that there are no cases where purchased power can be justified. The fact that a hotel power plant can produce power at a saving is due to the combination of low pressure steam utilization and electric power inherent in the hotel. The average hotel plant can recover a large percentage of the heat in the exhaust steam from the generating units, and this recovered heat is largely a by-product. An experienced mechanical operating crew is necessary in many hotels regardless of how the steam and electrical services are provided. This crew might in some cases, at least, be made more profitable by making it more productive.

COMPARISON OF HEAT, LIGHT AND POWER COSTS IN THE SAME HOTEL WITH AND WITHOUT POWER PLANT

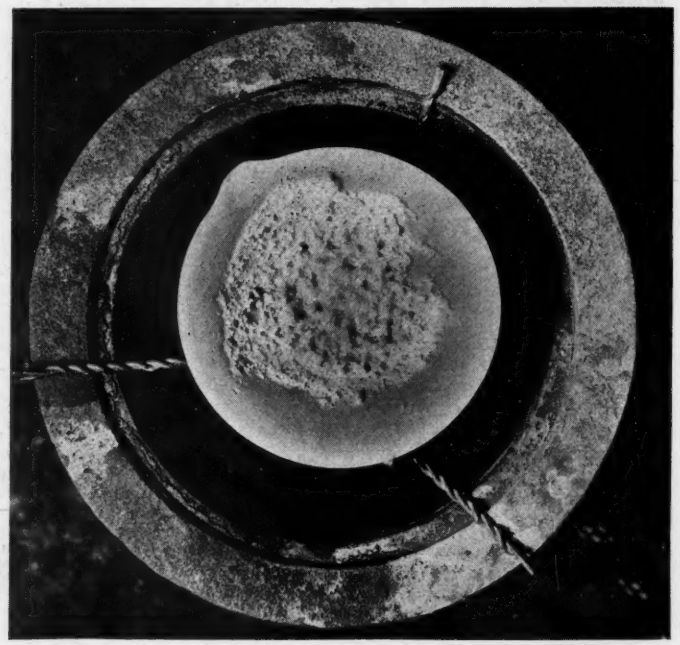
Month	Cost with Purchased Steam and Electricity	Operating Cost with Complete Steam and Electric Power Plant	Operating Savings with Complete Power Plant, per cent	
January ...	$ 4,832.00	$ 1,943.00	$ 2,889.00	60
February ..	4,157.00	1,772.00	2,385.00	57
March	4,449.00	1,931.00	2,518.00	57
April	3,558.00	1,730.00	1,828.00	51
May	2,540.00	1,775.00	765.00	
June	1,885.00	1,708.00	177.00	
July	1,785.00 L	1,688.00 L	97.00	5
August	1,908.00	1,816.00	92.00	5
September..	2,339.00	1,795.00	544.00	
October ...	3,445.00	1,811.00	1,634.00	47
November..	5,883.00 H	1,808.00	4,075.00	69
December..	4,941.00	2,020.00 H	2,921.00	59
Twelve Mo.	$41,722.00	$21,797.00	$19,925.00	49
Cost per room per yr.	104.30	54.49	49.81	
Cost per 1000 cu. ft..	18.09	9.45	8.64	

Author's Note: This power plant represents a cash cost of about $72,000 and it shows a gross annual saving of about $20,000 per year as compared to the former costs of steam and electricity. This is a gross return of about 28% on the plant investment. When dealing with necessities in the enterprise which the plant serves, this in the writer's opinion is not a bad gamble.

PICTURES

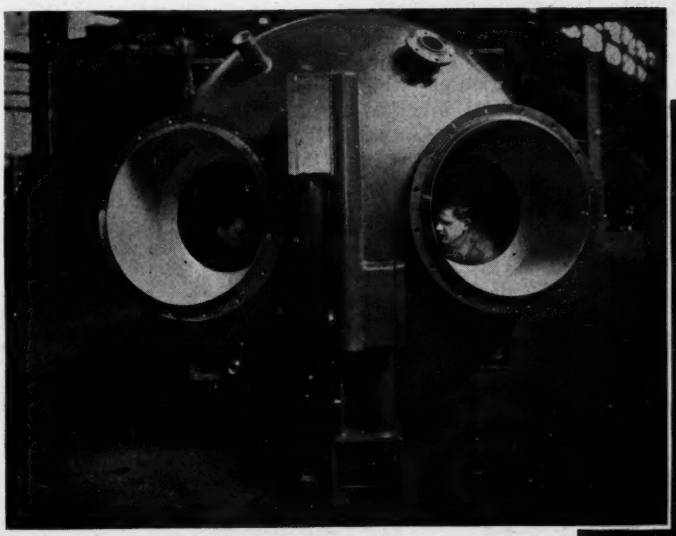


Taken during construction, the picture shown above is an interior view of Westinghouse's new "atom smasher" an exterior view of which is shown at the right. It shows a section of the 40 ft. vacuum tube through which electric particles are accelerated under high potential electric fields. The tube has an outside diameter of 17 in. and is the largest of its kind in the world. It consists of a series of porcelain rings separated by brass spacers. The outside view of the laboratory shows the pear shaped steel tank rising from the top of the brick building and which contains the high voltage generators used in producing the accelerating field. By the action of this high voltage, electrons and protons are caused to move at high velocity and then by directing these fast moving particles against various substances the atoms of these substances undergo fundamental changes. The equipment housed in this laboratory is only one of several methods by which subatomic particles can be accelerated to high velocity. Another method, and the one most widely used at present is by the use of the Cyclotron, an ingenious machine developed by Dr. E. O. Lawrence of the University of California. At the lower right is shown a small quantity of salt which has been made radioactive by bombarding it with the nuclei of heavy atoms of hydrogen. This radio activity is short lived—it persists only a few days but during this time the salt exhibits the radioactive properties of radium though to lesser degree.

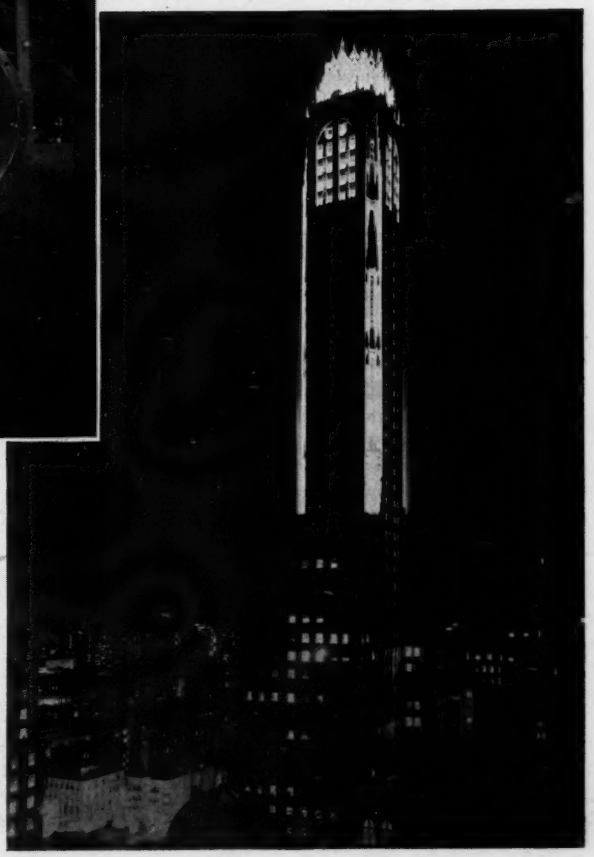


# of Engineering Interest

We have shown many pictures of Grand Coulee Dam during the years it has been under construction but none of them we feel had quite the beauty that this one has which strangely enough does not show the dam at all. Taken from a point high up on the adjoining hills, fog, like a great smoke screen is shown laying low over the entire valley. Only the great cranes project themselves up into the clear air above. Over 8,000,000 cu. yd. of concrete have already been placed in the great dam which leaves only a little over 3,000,000 cu. yd. to go.



Although the two men shown above are not far from the Atlantic coast line they are not getting ready to explore the bottom of the ocean in this submarine-like tank. Their chief interest is to put the finishing touches on the interior of this large oil circuit breaker tank in the Philadelphia Works of the General Electric Co.



At the right is a view of General Electric's New York city skyscraper in its new mantel of flood light. Flaming with the light of more than a hundred million candle power this 50 story tower became a conspicuous feature of uptown New York sky line at night when the lights were turned on for the first time on January 24. Searchlights of a new type installed at the four corners of the building send a beam of 25 million candle power in bluish white streaks up the corners of the tower.

THE A.I.E.E. CONVENTION

F. Malcolm Farmer
President, A.I.E.E.

SHORTLY BEFORE 1900, before the "turn of the century" as writers like to phrase it, a noted electrical scientist, his name slips our memory at the moment, ventured the opinion that most of the really great discoveries in the electrical art had been made; that there would be refinement but that there was little likelihood of many new fundamental discoveries being made. It would be interesting to know what this man's thoughts might have been if he could have attended the winter convention of the American Institute of Electrical Engineers held in New York during the week of January 22. There he would have been confronted with such an amazing variety of new developments in the electrical art as to bewilder even those who endeavor to keep pace with progress and who know, in general, what is happening. He would have found that many of the developments belonged to an entirely new art, the electronic art of which he understood nothing and he would have found other things of which he might have known something so changed as to be unrecognizable.

It takes a convention such as this to bring home, even to experienced electrical engineers, the full significance of the electrical art in the world today. The bewildering variety of new developments to which one is exposed leaves one with a strange mixture of feelings and thoughts. We may be overwhelmed by the complexity and variety of new ideas or we may be fascinated by the growing unity between independent links of thought, but we cannot fail to be benefited in one way or another by the mere exposure to these new ideas and techniques.

Those of us who understand the fundamental principles of the electrical devices that we use often do not know very much about the vast organizations and technical systems that lie behind them. This was brought home in a dramatic way to those at the convention who were fortunate enough to be able to attend the traffic control demonstration at the Long Distance Building of the American Telephone and Telegraph Co. This demonstration was based upon a fictitious major break in a telephone cable between Harrisburg, Pa., and Philadelphia. Seated in the room of the Traffic Control Bureau in New York and provided with telephone headsets the members in the audience could listen in on the conversations and discussions between the supervisors and operators at the three traffic control bureaus in New York, Cleveland and Chicago and at the central offices in scores of cities throughout the nation. With the first report of the trouble, telephones and teletypewriters flashed information between the control bureaus and the key central offices. Advice, reports, suggestions, sped from New York to key points in a dozen directions. As the action proceeded an increasing number of circuits were arranged to by-pass the break. On a great circular display board was recorded the minute-to-minute condition of each circuit.

Thus, in a fast moving fifty-minute presentation there was re-enacted every important move that normally transpired in ten hours in a case involving a major cable break.

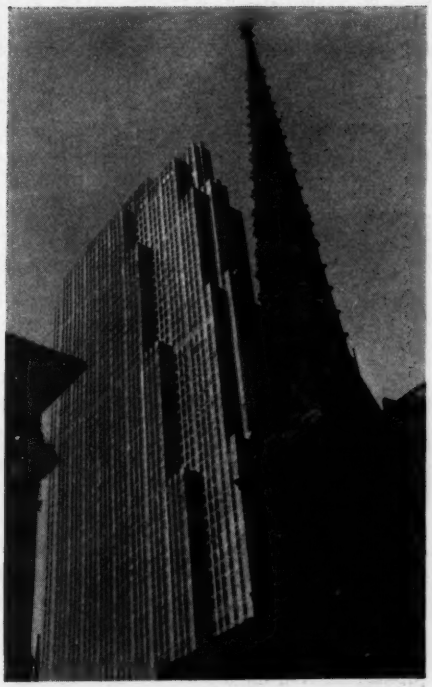
Philip Torchio
Edison Medal, 1939

This demonstration was only incidental to the proceedings of the convention but it was nonetheless important. Those witnessing it were given a new insight into the mechanics of our vast national telephone system and this knowledge, though not directly useful was inspiring and potentially valuable.

The Technical Sessions

As in previous recent conventions of the Institute, the technical sessions were largely in the nature of symposiums. The papers were grouped so that those specializing in particular fields could discuss the subjects with which they were most familiar with others similarly minded. There were sessions, for example, devoted entirely, or almost entirely, to electric welding; other sessions covered only air blast circuit breakers, or lightning protection, power transmission, electronics, etc. There was one session devoted entirely to the restoration of service from large metropolitan power systems after complete shut-downs. This session was of added interest to those who were also able to attend the traffic control demonstration already described since it emphasized a wide variance in tech-

AT NEW YORK



nique between the procedure used by the power companies as compared with the telephone company in matters involving similar basic events.

Atomic Disintegration

A high point of the week's activities was the lecture on Wednesday evening, January 24, on Atomic Disintegration by Dr. Enrico Fermi, the distinguished Italian physicist and winner of the 1938 Nobel Prize in Physics and the demonstration of atomic disintegration by Dr. John R. Dunning of Columbia University. This lecture and demonstration was preceded by the presentation of the Edison Medal to Philip Torchio and of the Hoover Medal to Gano Dunn, which quite characteristically was unnecessarily tedious.

Dr. Fermi's exposition of a complex subject in simple terms, however, was admirable and reflected the skill of a master. After considering the principle of nuclear bombardment, that is the bombardment of the nuclei of atoms by high speed electrically charged or neutral particles, Dr. Fermi explained that it had been possible for a number of years to effect comparatively simple transformations of atoms by these processes. For example, when Beryllium (Be) of atomic weight 9 and atomic number 4 is bombarded by Helium of atomic weight 4 and atomic number 2, the result is Carbon with atomic weight 12 and atomic number 6 plus a neutron (atomic weight 1, atomic number 0). Expressed as an equation this transformation is

$$He_2^4 \longrightarrow Be_4^9 = C_6^{12} + n_0^1$$

With these bombardments the products of the process differ from the original element by only a few units. In other words with such ordinary bombardments, elements can be changed from one to another only if they are close together in the periodic table of elements.

There was, therefore, a great sensation among nuclear physicists last year when Hahn and Strassman announced that by the bombardment of uranium (atomic number 92) with neutrons they found definite evidence of the formation of some radioactive isotopes of barium (atomic number 56). Such a change by 36 units in the atomic number, Dr. Fermi pointed out, had never been considered possible before and subsequent investigation showed that it corresponds to a nuclear reaction of an entirely new kind, in which the uranium nucleus splits into two fragments of comparable size.

This "fission process" is brought about by bombardment with fast moving neutrons having energy above one million electron volts and by slow moving neutrons having energy corresponding to thermal agitation, equivalent to a small fraction of an electron volt.

The process was demonstrated, using slow moving neutrons by Dr. Dunning by means of the equipment set up on the stage of the auditorium.

Aside from its scientific interest this fission process might lead to developments of far reaching importance as it opens up at least one possibility of exploiting the fission of uranium for the production of nuclear reactions on a large scale. Power engineers please note.

Restoration of Service After Shutdown

In the limited space available here we shall not attempt to present anything more than a general "picture" of the convention. Many of the 84 odd papers presented at the technical sessions were of a highly specialized nature of interest only to those working in special fields and they have only a remote interest to the majority of the readers of this magazine.

Among the sessions of particular interest to those in the power field was the one already referred to, dealing with the restoration of service in metropolitan areas after complete shutdown. Four papers on this subject were presented at this session involving respectively the systems and procedure of the Detroit Edison, the Philadelphia Electric, the Duquesne Light and the Consolidated Edison Company.

The papers considered the comparative merits of so-called "loose" and "tight" system arrangements, rings and parallel arrangements, network and radials

and sectionalization schemes. The systems considered and the technique involved in restoring service differed considerably among the various companies but there was comparatively little comment. All of the papers stressed the need for training of personnel and outlining the responsibility of the operators. In some instances rehearsals and drills were advocated while other companies preferred to depend upon the initiative and knowledge of the operators for proper action in times of emergency.

Dr. John R. Dunning of Columbia University, who demonstrated atomic disintegration

Although this question is essentially one of an electrical nature, it also involves the boiler plant and the water supply. W. E. Caldwell of Consolidated Edison brought up the question of speed of response of the boilers. Some accumulator effect he said was desirable in the steam-combustion setup to coast over the fluctuations of demand arising in system emergencies. An instantaneous pickup of 25 per cent, it was brought out, is a reasonable boiler plant expectation, though pickup rates of 35,000 lb. per hr. per min. with stokers were described. In another case an increase from 50,000 to 120,000 lb. per hr. in 27 seconds was reported.

This whole subject is one of vital importance to the power companies operating in metropolitan areas, though as E. C. Stahl of Consolidated Edison pointed out, too much emphasis had been placed on interruption and restoration in the titles of the papers. Extensive interruption on our large systems are rather remote possibilities and complete shutdown should not be envisioned.

The Amplidyne

Of considerable interest to both power and industrial engineer alike was the session on industrial power applications at which three papers on the "Amplidyne" amplifier were presented by a group of General Electric Co. engineers. The amplidyne is a dynamo-electric amplifier developed to fulfill a function in power engineering similar to that filled by the vacuum tube amplifier in the communication field. As pointed out by Dr. E. F. W. Alexanderson, who delivered the first paper on the Amplidyne at this session, the term amplification is one that has seldom been applied to processes in power engineering. Strictly speaking, a radio amplifier is only a form of control because we always tap a new source of power and the function of the amplifier is to control the power level. On this ground Dr. Alexanderson said we could regard an ordinary d.c. generator as an amplifier because the power output is controlled by the current in the field winding. Such a terminology would, however, be misleading because when we say amplification we imply something more specific than when we say control.

When it became apparent that amplifiers were needed in power engineering it was natural to turn to the vacuum tube, particularly to the thyratron. The thyratron found many successful uses in power applications and it was this fact that led to a consideration of other methods of amplification and which finally resulted in the dynamo-electric type of amplifier described in the papers presented at this session.

The amplidyne is a 2-stage amplifier incorporated in one dynamo electric machine. In its physical structure it resembles a direct current motor with two sets of brushes, one set being short circuited and placed at right angles to the power brushes. (See accompanying diagram.) The first stage of amplification is from the control field to the short circuited brushes; the second stage is from the short circuited brushes to the power brushes. Each stage gives an amplification of approximately 100 to 1, therefore an amplification of the order of 10,000 to 1 can be realized by the system.

A considerable number of these amplidyne generators have been applied to industrial processes and M. A. Edwards of General Electric described these.

While these papers were of great interest, most of the discussion was by Westinghouse engineers who compared the amplidyne with other devices already available for similar control functions. C. R. Hanna of Westinghouse compared it with an electro-mechanical rheostatic type regulator such as the Silverstat and pointed out that such an assembly under certain conditions of control might provide an amplification of 200,000 to 1 against the amplidyne's 10,000 to 1.

K. M. Sparrow and E. C. Watson also both of Westinghouse raised numerous questions concerning the theory and operation of the amplidyne and implied that its adjustment would involve certain difficulties. In replying to these comments Mr. Alexanderson said that they had pointed out these difficulties to forestall any trouble and that if proper adjustments were made no difficulties need be encountered. He promised, however, to answer the criticisms fully in a written discussion.

Dr. Enrico Fermi Who lectured on atomic disintegration

The Excitron Rectifier

At the session devoted to Electronics considerable discussion was invoked by O. K. Marti's (Allis-Chalmers) paper on the Excitron Mercury-arc Rectifier. The Excitron is a single anode rectifier with continuous excitation. Conventional rectifiers of the multiple anode type, Mr. Marti said, had been perfected to a very high degree in the last decade but they have one drawback, the arc drop increases with the size of the rectifier tank or tube. He then cited the attempts made to effect a low arc drop by sectionalizing the rectifier into as many tanks as anodes, a design which was greatly stimulated by the introduction of a means of intermittent ignition. Successful as this type of "Ignitron" rectifier was, Mr. Marti implied that it had drawbacks and so the Allis-Chalmers Co. had been encouraged to develop a multiple tank rectifier with continuous instead of intermittent excitation; this was the Excitron rectifier.

Westinghouse engineers disagreed quite vehemently with this paper. G. F. Jones said that the "Ignitron" had been in commercial operation for three years, questioned the accuracy of Mr. Marti's arc drop values and criticized the "Excitron" as being complicated and having many moving parts. J. H. Cox also did not agree with Mr. Marti's paper but was glad to note that Mr. Marti after denouncing single anode tank rectifiers last year now came to accept them.

All of which was quite exciting but in the end nobody was convinced of anything that he had not believed in the beginning. Dr. Slepian of Westinghouse was gracefully mild and generous in his comment and discussed the relative performance regarding arc back between continuous and intermittent excitation. In his own experience he said he had found much better operation with intermittent excitation.

In reply to those who criticize his data, Mr. Marti invited critics to come to Milwaukee with their own instruments and check the results for themselves.

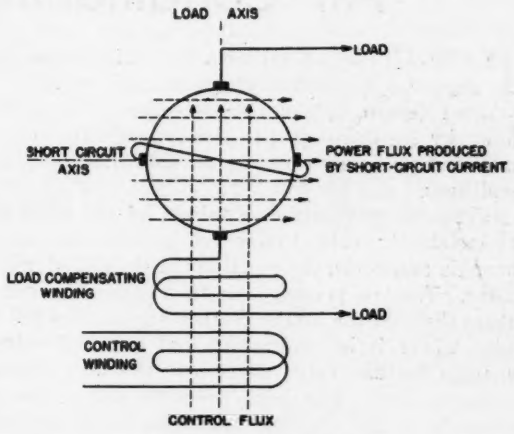
Air Circuit Breakers

Progress in the development of air circuit breakers was reflected in the papers presented at a session entirely devoted to that subject. New types of air circuit breakers were described by representatives of G. E., Westinghouse, Allis-Chalmers and Metropolitan Vickers. Discussion at this session was far less animated than that at the one just described though Dr. Slepian reiterated his lack of faith in the so-called displacement theory propounded in the paper on the Cross-Air-Blast circuit breaker by Messrs. Prince, Henley and Rankin. He showed enlargements of the arc pictures presented in the paper in support of his contention for diffusive turbulent phenomena.

While the presentation of this group of papers devoted entirely to non-oil type circuit breakers was an event of great significance in the progress of circuit interruption technique, C. M. Gilt of the Consolidated Edison Co. reminded those present that despite its success the air breaker would have to compete with the oil breaker and that there had been very few oil breaker fires.

Hydrogen Cooling

Central station engineers were much interested in a paper describing the operation of hydrogen-cooled synchronous condensers and generators by Philip Sporn and F. M. Porter, both of the American Gas & Electric Service Corp. In this paper the authors reviewed the results of operation with 8 condensers and 2 generators over a period of some 12 years. In general the reliability of condensers was as great or greater than with air cooled units. Supplementing the data presented in the paper, F. A. Lane, also of the American Gas and Electric, presented data on the operation of the hydrogen cooled generators at Logan and Windsor Stations. From 1937 to September, 1939, the 50,000 kw. generator at Logan, he said, had given 400 days of service without loss of time or any difficulty with the hydrogen cooling equipment. With ½ lb. pressure the machine had carried 48,000 kw., which represented a loading 20 per cent above rating, at 99 per cent power factor for an hour. The hydrogen cost he said amounted to about $275 per year.



The Amplidyne Generator

22,500 r.p.m. Generators

There were many papers at the Communication and Instrument, as well as other sessions, devoted to transportation, lighting, relaying, etc., that were of general interest to those not specifically working in these respective fields. A paper entitled "Electric Power for Airplanes" by W. J. Clardy of Westinghouse, and presented at one of the Transportation sessions brought home to those not associated with this field the remarkable work done in reducing the size and weight of power equipment used in airplanes. The 400 cycle, 3 phase, 12.5 kw. 120 v. alternator weighing about 100 lb. described by Mr. Clardy was an interesting example of this development but this was as nothing compared to the 6 hp., 110 v., 400 cycle motor operating at 22,500 r.p.m. at full load which weighs only 15 lb.! Since minimum weight is essential in all airplane requirements the 400 cycle 110 v. 3 phase system had been developed for large airplanes.

G.E.'s High Frequency Course

Of interest to educators and employers of young electrical engineers was a paper by A. R. Stevenson, Jr., and Simon Ramo, both of the General Electric Co., describing a new post graduate course in industry in high frequency engineering. This course is a new section of a 3 yr. post graduate course known as the "Advanced Course in Engineering" which has been in operation at General Electric for 16 yr. The first year or "A" class is common to all sections of the Advanced Course and is made up of 30 to 40 men of the testing department who have been with the company only a short time. A few of the 12 or 15 men selected each year from the "A" class for the upper classes are given the final two years of that part of the course dealing with electronics and high frequency. During the second and third years the mathematical, physical and design material is developed simultaneously so that uppermost in the student's mind is the regard for the analytical

Continued on Page 68

Streamlined Air Conditioning

TYPICAL CYCLE OPERATION of the new Westinghouse hermetically sealed unit recently announced (see p. 813 of the December 1939 issue) is shown by the drawing with the approximate temperatures and pressures given as an indication of general conditions.

From the gas suction manifold of the evaporator the relatively cold Freon refrigerant gas sweeps through, and cools, the windings of the sealed driving motor. The low pressure gas then enters a manifold, passes through the intake feather valves, into the cylinder where it is compressed and expelled through separate feather valve ports into the high pressure discharge line. The high pressure refrigerant gas passes down into the condenser where it is condensed by contact with the water-cooled condenser tubes. The liquid refrigerant enters the liquid line from the bottom of the condenser, passes through a strainer and enters the expansion valve. The liquid begins to expand into a gas as it passes through the expansion valve and distributor tubes, and continues to expand during its course through the evaporator.

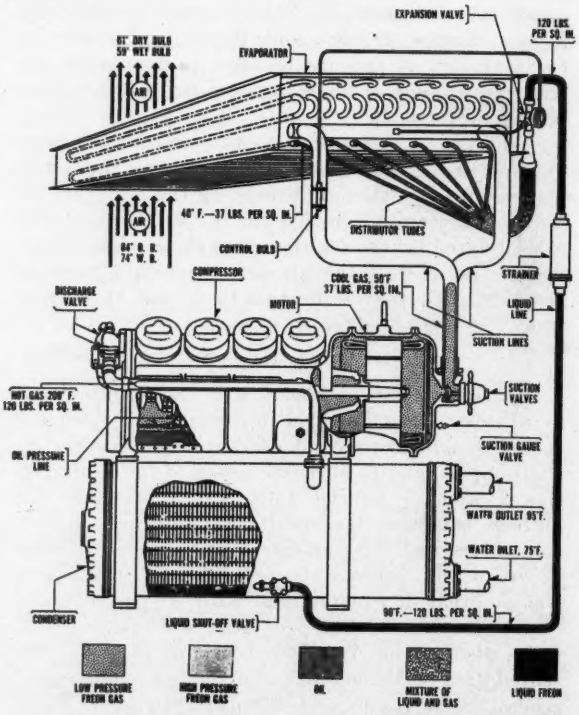
In this process, the air passing over the evaporator fins is cooled, as a portion of its heat is absorbed through the evaporator tubing walls by the boiling refrigerant inside. The Freon is completely vaporized by the time it reaches the valve control bulb, and enters the suction line as a low pressure gas to complete the cycle. As an indication of the thought and attention given to detail in connection with modern machinery production, the following brief outline of the manufacturing procedure in connection with the new unit is given. To insure the accurate fits necessary for long life, working tolerances are held as close as in the manufacture of engines for airplanes and automobiles. For example, piston pins are matched to fit in the piston and upper end of the connecting rod. Clearances for the 0.015 in. valve reeds are held between 0.001-0.004 in.; cylinder depth is gaged from the main bearing center line to plus or minus 0.00075 in.; cylinders must be true throughout their length from —0 to +0.0005 in. Manufacturing methods include an air conditioned assembly room, motor driven wrenches to speed production, hydraulic gage wrenches for uniform tightening of cylinder head bolts and special machining and balancing facilities.

All parts of the compressor are completely washed before sending into the assembly room. The connecting rods, bearings and all of the smaller parts are placed in a basket which oscillates vertically in a cleaning solution. They are then blown off, using air under high pressure. The large castings are set into a basin and the cleaning fluid is sprayed on them while scrubbing with brushes. They are then dried by using a jet of high pressure air.

The unit is assembled in a glass enclosed, air conditioned room in order to keep out dirt and dust. Shaft and bearings are first put into place in the crankcase. The cylinder blocks are then bolted into place and the pistons and rods assembled in position. The oil pump and oil piping is assembled next and the compressor is ready for the run-in operation. The compressor minus the cylinder heads and motor is set up on a special run-in stand and has a minimum of 8 hr. run-in.

After the compressor is run in, the motor is assembled into place and the cover plates, valves, cylinder heads, etc., bolted on. In order to have the correct bolt tension on the gaskets, special wrenches are used which have a dial to register the actual force which the operator is using. Air at 200 lb. per sq. in. pressure is put into the finished compressor and it is immersed into a tank of cleaning fluid.

This gives a preliminary check on the entire machine for leaks and cleans it to facilitate painting. After passing this test the compressor is evacuated and charged with "Freon" refrigerant. The unit is then put into an oven and heated until the refrigerant pressure is 150 lb. per sq. in. It is then tested for leaks by using a special halide leak detector torch. This torch is so constructed that a refrigerant leak will change the color of the flame and it is very sensitive to the smallest leak. After passing all the leak tests the unit is put into an electric oven and heated to 255 deg. F. While in the oven it is connected to a vacuum pump and dehydrated until a special moisture analysis test indicates that all moisture has been removed. The unit is then connected to a test stand and operated under full load at normal operating conditions.



A typical cycle for the newly developed 100 t. hermetically sealed Westinghouse air conditioning unit., The compressor, motor and condenser are built as an integral unit occupying small space and because of the motor construction and arrangement can be installed in out of the way and unventilated areas

Jacket water temperatures of 212 deg. F. and over proven practical in operation, and greatly widens waste heat recovery possibilities. Savings of up to 25 per cent per ton of ice possible in refrigeration plants.*

Better Waste Heat Recovery

BETTER METHODS of waste heat utilization in connection with gas engine applications is of profit-producing concern to power-using industries. The improved procedures to be described involve what is known as high-temperature cooling of internal combustion engines, and are based upon the use of jacket cooling-water at temperatures above 212 deg. F.

An average of 30 per cent of the total energy content of gas fuel is wasted as heat into the jacket cooling-water and another 35 per cent into the exhaust gases. Obviously, any improvements in the means of putting to useful purposes this large proportion (65 per cent) of waste heat would considerably broaden the field of power applications in which savings can be realized by the use of natural-gas-fueled internal combustion motors. To date, jacket-water and exhaust-gas heat from gas engines has been used either: 1, to heat water for a variety of uses such as boiler make-up, washing operations, space heating, or heat exchanging operations in any number of chemical and thermodynamic operations; 2, to generate steam for plant heating, equipment sterilization, or processing usage; 3, to produce warm air for space heating, or drying operations.

The usual method is to conduct the heated-up cooling-water within a closed system through some type of heat exchanging coil, and to capitalize upon the exhaust-gas heat, if at all, either by: 1, conducting the exhaust gases directly through a second heat exchanging device such as a warm air heater or a boiler; 2, water-jacking the exhaust line and connecting it as a temperature booster in series with the engine-cooling-water system; or, 3, water-jacketing the exhaust line and use it to heat water in a circulating system.

Operating Tests

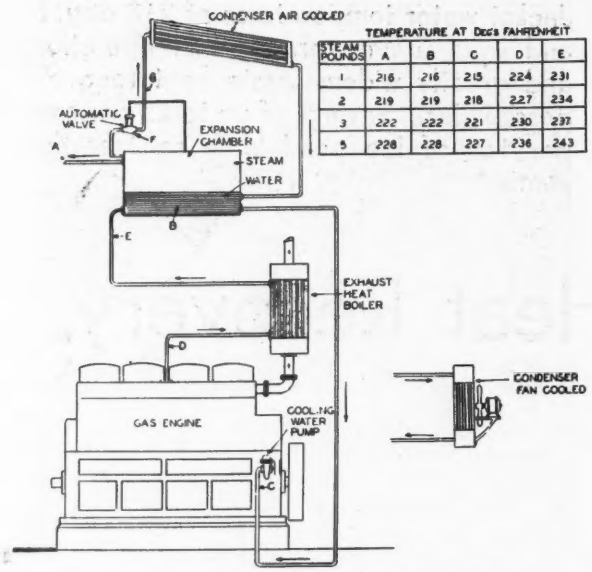
Because of the fact that engine jacket water is generally maintained at temperatures under 200 deg. F., it has been difficult to use such water directly without additional heat being supplied from some outside source other than the engine itself. Experiments have been carried on during the past few months in Southern California, following several years of development work abroad, in the high temperature cooling of internal combustion engines. By "high temperature cooling" it is meant that instead of maintaining jacket water temperatures of approximately 160 deg. F., the temperature is raised to 215 and over. In some instances, temperatures of jacket water of from 300 to 400 deg. F. have been tried, but, at these higher temperatures, lubrication difficulties have been experienced. At the lower temperatures, from 220 to 250 deg. F., no mechanical difficulties have been encountered.

It will immediately be apparent that with waste heat from the jacket water at 212 deg. F. and over, the uses for such heat in manufacturing are almost unlimited. For example, in the manufacture of ice the standard ammonia compressor plant can be very nicely powered with gas engines. Assume for instance a plant with an ice capacity of 40 t. per twenty-four hr. A 100 hp. gas engine operating at 70 lb. b.m.e.p. to drive an ammonia compressor will be cooled with jacket water at a temperature of 220 deg. F. and will have an exhaust temperature of 950 deg. F. The amount of waste heat available from the engine jacket water will be approximately 250,000 B.t.u. per hr., with approximately 227,500 more available from the exhaust heat using a waste heat boiler of 65 per cent efficiency. This is heat which may be actually and economically recovered.

By applying the waste heat to operate an absorption refrigeration machine such as the new Williams Air-O-Matic, refrigeration may be developed for reduction of ice-can water temperatures and fore-cooling of the liquid ammonia. The reduction in power expended per ton of ice manufactured will be as great as 25 per cent. Assuming that the present suction temperature is not already at the minimum operating point, the plant capacity may be increased by approximately the same amount, namely 25 per cent without increase in gas consumption or power, by the device of increasing compressor speed, thus decreasing brine temperature.

It might be well to add that the average cost of an ice manufacturing plant is approximately $1,000 per ton of capacity. The use of an absorption machine with waste heat obtained from high temperature cooling of the gas engines may be used to increase the plant capacity approximately 25 per cent with an increased plant investment cost of only about

*This article is based on a report of the Gas Power Committee of the A. G. A. covering data on improved methods of waste heat utilization and made available since the Gas Engine Handbook (see New Engineering Books in this issue) was published. Most of this is quoted direct from a report by D. W. Reeves, Oklahoma Natural Gas Co., chairman of the committee.


CONDENSER AIR COOLED
TEMPERATURE AT Degs FAHRENHEIT
STEAM POUNDS | A | B | C | D | E
1 | 216 | 216 | 215 | 224 | 231
2 | 219 | 219 | 218 | 227 | 234
3 | 222 | 222 | 221 | 230 | 237
5 | 228 | 228 | 227 | 236 | 243
AUTOMATIC VALVE
EXPANSION CHAMBER
STEAM
WATER
EXHAUST HEAT BOILER
CONDENSER FAN COOLED
GAS ENGINE
COOLING WATER PUMP

Layout of waste heat recovery system for high temperature gas engine cooling. From 4 to 5 lb. of 230 lb. steam is available for each brake horsepower of load

$200 per t. for the additional output, with, of course, the incidental reduction in operating cost of 25 per cent per ton.

Greater Flexibility

There is an added advantage to be derived from high temperature cooling, namely the automatically controlled heat balance obtained thereby. When an engine jacket water temperature of 160 deg. F. is maintained with water circulating through an engine at the rate of approximately 50 g.p.m., it is possible that there will be times when the full heat will not be required or used. When engine temperatures are maintained below the boiling point, for example, 160 deg. F., the heat from the engine jacket water and exhaust, if used for outside purposes, must be recovered at a continuously uniform rate. If all of the heat is being absorbed in a heat exchanger at one time and only a portion of the heat is absorbed or used at another period during operation, the operating temperature of the engine so fluctuates as to cause considerable difficulty in operation.

It is likewise essential that the temperature differential between incoming and outgoing water from engine water jackets be maintained at a minimum of not over 20 deg. F. This is exceedingly difficult where the waste heat from the engine water jackets and exhaust is being utilized for outside purposes with temperatures under 212 deg. F. At the higher temperature it is possible to take all or any portion of the heat without upsetting the balance in the engine.

Suggested Hook-Up

Operation of an engine using the high temperature method of cooling is best shown in the accompanying illustration. It illustrates an installation where a condenser may be installed on the roof, either cooled atmospherically or by means of a fan. The expansion chamber B contains water at 212 deg. F., which is at the boiling point where it starts to liberate steam. The water leaves the expansion chamber, passing through the main cooling water circulating pump. By the time the water enters the engine, the temperature has dropped to approximately 211 deg. F. Passing through the engine, the water will increase in temperature to approximately 220 deg. F.

As the water leaves the engine and is passed through the exhaust heat exchanger or boiler, the temperature rises to 227 deg. F. and, mingling with the water in the expansion tank, is dropped to 212. The steam liberated in the expansion chamber may be lead away through pipe A for any indirect heat usage desired, the condensate being returned to the expansion chamber which is not shown.

An automatic valve F is installed in the line G connected to the condenser. This valve is set from 1 to 2 lb. above the pressure of the steam being used at A. Should the requirements for steam at A decrease or cease entirely, the pressure in the expansion tank will rise, the automatic valve F will open and the steam generated will pass through the condenser, from which it will return to the expansion chamber. Usually atmospheric pressure steam is not sufficient for average plant requirements, and in consequence, the pressure must be raised to obtain the higher temperatures. A table of temperatures at various points in the system is given in the illustration for pressures from 1 to 5 lb. in the expansion chamber.

Where a tank of water is to be heated, the engine water (or steam from the expansion chamber) may be taken direct to a heat exchanger located in the water tank and then returned as condensate. Where the waste heat from the engine is desired for space heating, unit heaters or condensers may be installed wherever the heating is required and the engine water (or steam from the expansion chamber) may be piped to and from the individual unit heaters (used as condensers when steam is generated).

When warm air is desired from gas-engine waste heat, it is not necessary to install condensers equipped with motor driven blowers or fans near the engine, with an elaborate and expensive system or duct work to the locations in the plant where the heat is required. The piping of the engine water, or steam, is much simpler and requires less space with only a slight addition in power required for the circulating pump, which will be more than offset by the smaller blower needed at the point of heat application. The heat losses in the system where engine water, or steam, is piped to and from the unit heaters, will be appreciably lower than where the heated air must be transmitted through long ducts to various portions of the plant.

The high temperature method of cooling natural gas engines makes available from 4 to 5 lb. of steam at 230 deg. F. per brake horsepower developed by the engine. For example, with a 120 hp. engine operating at full load driving a 75 kw. electric alternator, approximately 480 lb. of 230 deg. F. steam could be obtained from the engine for auxiliary heating.

Diesel Ice Plant Costs

Four and one-half years Diesel operation shows a cost of about 36 ct. per ton of ice at a substantial saving over purchased power

SMALL POWER CONSUMERS have insufficient volume to earn the preferential power rates of larger competitors, which often constitutes a major item of manufacturing expense, but this does not eliminate the necessity of meeting competitive prices. The problem may be further complicated by the requirements of intermittent service during slack months when utility demand or fixed minimum charges make it uneconomical to operate for brief periods only.

The seasonal character of the ice business, together with the rate premium in comparison with competitors, led G. B. Knapp, president of the Springdale Ice & Coal Co., Springdale, Conn., to seek ways and means of reducing the power item of manufacturing cost. His solution to this universal problem should be of interest to many executives faced by similar circumstances. Twenty-two years experience in operating (1913 to 1935) emphasized the importance of a dependable as well as economical power supply, so with these two considerations in mind, he investigated the possibilities decided upon Diesel drive. The first engine to be installed was a 3 cyl., 100 hp., Atlas-Imperial Diesel, which was placed in service operation in May, 1935.

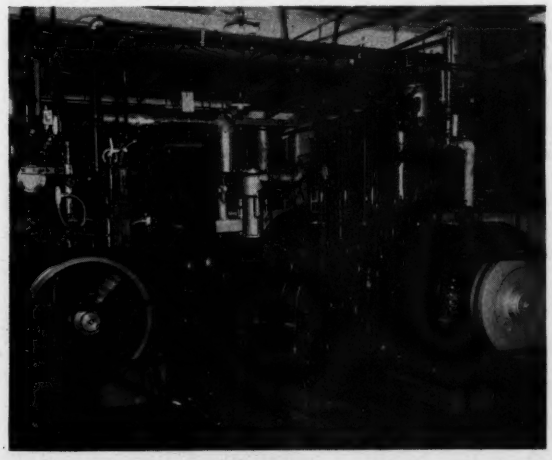


Fig. 1. The 100 hp. Diesel on the right, driving a 9 by 9 in. compressor and a direct connected generator, was installed in 1935. The 55 hp. unit on the left, driving a 6½ by 6½ in. compressor and a V-belted generator, was installed in 1937. At the end of 1939 the first had operated 18,234 hr., the second 7084 hr.

Fig. 2. During 4½ yr. Diesel operation 22,257 t. of ice have been produced at a cost of $7972.32, about 36 ct. per t. The scorer at the left and the conveyor are part of the automatic vending machine in which a customer can insert dimes at any hour of the day or night and get the size cake desired through a chute, regardless of whether an operator is on duty

This unit is directly connected to a 9 by 9 in. York ammonia compressor at one end and an Electric Machinery Co. generator at the other. Since it was not necessary to increase plant personnel, an accurate comparison of Diesel versus purchased power costs is easily computed by estimating the latter from records of previous years, and adding up actual charges for Diesel fuel, lubricating oil and maintenance. For the period of two years from May, 1935, to June, 1937, power costs were reduced from approximately $8000 to $2290.21, a saving of 65 per cent. During this time no stand-by service was maintained nor was production interrupted except for normal shut-downs to permit routine engine maintenance.

On the basis of this record, and to accommodate a demand for increased plant capacity, a second Diesel-generator-compressor unit was installed and placed in service operation in June, 1937. This was a smaller 3 cyl. Atlas-Imperial engine rated at 55 hp. and direct connected to a 6½ by 6½ in. York compressor and, through V-belt drive, to a Westinghouse generator. Over a two and half year period from June, 1937, to December, 1939, Diesel fuel, lubricating oil and maintenance charges totalled $5683.11 as opposed to approximately $18,750.00 had the plant operated on purchased electric power. In this period also, with both engines operating, no interruptions in ice production occurred other than the previous mentioned routine maintenance. At the end of 1939, the first engine has operated a total of 18,234 hours; the newer and smaller unit a total of 7084 hours.

SAVINGS $18,736.08

In analyzing the previous operating figures, it should be noted that fuel and lubricating oil charges were compiled from actual bills paid, hence, are exact cost figures. The remaining item of maintenance was arbitrarily figured on the basis of approximately 4.5 ct. per t. of ice produced to build up a reserve for normal repair and replacement in

Fig. 3. The tank room has a capacity of 486 three hundred pound cans. Water is pumped from artesian wells at the plant

the future. This figure does not therefore represent actual money spent on machinery maintenance during the years against which it is charged.

Total summation for both periods is as follows: During 4.5 yr. of Diesel operation, 22,257 t. of ice were produced at a cost of $7972.32. On purchased power the cost would have totaled $26,708.40 on the basis of the same production and at the rate received previous to installation of the Diesels. The total saving amounts to $18,736.08 and Mr. Knapp reports that both engines have paid for themselves in addition to earning a substantial net profit.

While the ratio of costs is approximately typical of this industry, both purchased power and Diesel-generated-power cost items are said to be somewhat higher than average.[1] The plant in question is relatively small in size and production, hence, either type of power carries a certain premium. Also, the increase in Diesel cost is attributable to higher than average fuel oil prices, since the most economical grade of fuel has not been available in this locality, and to the higher than normal maintenance reserve that this owner charges against his plant.

In fairness to the utility, it should be stated that a lower purchased power rate was placed in effect after this plant was converted, which would normally reduce the figure for this item as given previously. However, minimum demand charges and requirements nullify such a saving since, according to the owner, the seasonal character of his business together with the relatively small amount of power consumed make it unprofitable to operate on purchased power.

In this connection, the flexibility of the present Diesel-compressor generator arrangement provides the further advantage of flexibility in operation. The smaller unit easily handles normal winter demands; as the weather grows warmer, the larger unit has sufficient capacity, permitting the other to be shut down; while in the hot summer months both are required. Thus, except for brief periods each year, one unit is always in reserve, which provides an ample factor of safety to guarantee uninterrupted production. In view of the first 2 yr. of operation on one engine, this hardly seems necessary but it permits routine overhaul at the convenience of the plant staff and assures the operation of each engine within its most economical load range.

The engines have Alnor exhaust temperature pyrometers, Maxim silencers, Burgess air intake filters and Minneapolis-Honeywell safety controls which automatically shut off the fuel when lubricating oil pressure drops below a safe point or cooling water temperature exceeds a predetermined level. Electric current from the generators operates lights and motor-driven pumps, blowers, hoists, etc., throughout the plant. When both engines are shut down lighting is supplied by the city circuit.

[1]Compare these actual costs with the estimate costs in Ice Costs—Diesel vs. Electric Power, page 713, Nov. 1939.

The A.I.E.E. Convention at New York

Continued from Page 63

processes as useful tools in the solution of engineering problems. The subjects change from year to year although the fundamental nature of the lecture material is preserved. The technical lectures are given by a great many men from many different departments. Under this program by the end of three years the men have received a thorough training in the fundamentals underlying electronics and high frequency engineering and have learned to use the analytical tools needed to apply theory.

The presentation of this paper naturally was received with a great deal of interest and the discussion was particularly enthusiastic. Most of the educators were gratified by the emphasis placed on mathematics in the formation of physical concepts.

Four days of the convention were devoted to the presentation and discussion of technical papers. The fifth day, Friday, January 26, was given over entirely to inspection trips to places of general and technical interest, of which the traffic control demonstration described at the beginning of this article was one. As in the case of other recent conventions of the Institute in addition to the regular technical sessions, a number of conferences were held on selected subjects. The character of these conferences is strictly informal, as a rule, except for an introduction of the subject under consideration by the chairman, no formal papers are presented and the discussion is spontaneous and without restraint. It is a general rule at these conferences that nothing said by anybody will be published and that results in a free interchange of knowledge. At this convention there were conferences on Electric Welding, Feedback amplifiers, Networks, Sound, Transportation, the use of electronic devices and on Standards and Definitions. All the conferences were unusually well attended and in many ways they formed the most interesting feature of the entire convention.

The PRACTICAL ENGINEER *and* ELECTRICIAN

R. H. MORRIS, EDITOR

Scrambled Economics

Our old pal, Triple Expansion Charlton with a professional dislike for professional engineers and with more miscellaneous information in his head than there is in the encyclopedia, points out very pertinently that efficiency is not always economy.

As an example he cites a mill owner who remodeled his boiler room on the positive guarantee of fuel and labor saving. Admitting the savings he refused to pay the bill for, while he was able to fire two firemen, he had to hire them back, together with an extra man and a team, to load and dispose of the wood waste saved by more efficient operation.

Engineering is 50 per cent knowing how, and 50 per cent knowing why. The first is the easier of the two.

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A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago, Ill.

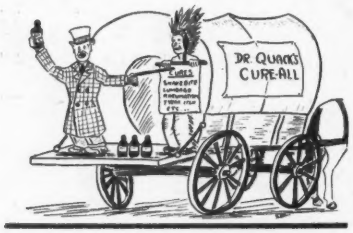
Labor and management should work together and the author feels that they can, but lest you take him seriously when he says "written by a fugitive from kindergarten, who has worked with his fellow men for the past 18 yr." we hasten to add that this is an article we have long searched for. Full of proven suggestions, it summarizes concisely two decades of observation and the practical experience of five companies with definite programs based on employees as partners in industry. He feels that the success of such a program lies 98 per cent with the management. He may be right and he may be wrong, in any event further comment from both sides will be welcomed—not political tirades, justification of past action, nor recital of past wrongs—but constructive suggestions based on conditions as they exist today; details of programs that work; reasons why others fail; the course of action open to companies too small to employ a specialist in this field; and last, but most important, the private reactions of those who work in plants where such programs are being tried.

—it's up to the management

By J. C. De Foe*

HERE IS A PLAN that kept both the management and employees posted on progressive developments and has also resulted in improved employee relations. Time after time the management and employee representatives met across the conference table and instead of bridging the widening gap between the management and employees, it seemed only to bring up more points of controversy. After months of this dickering the management finally decided to turn their present personnel manager into a bookkeeper and replace him with a practical engineer who had rubbed elbows with men digging a ditch, yet he had sat in conference with company officials.

At first this appointment looked like a "noble experiment" where the management was willing to give their support



—a bit of showmanship helps

to a man who was not schooled in personnel management, yet he finally produced the desired results for the management. Today the management and employee representatives are meeting over the conference table and at the termination of each meeting there are noticeable improvements in personnel or employee relations.

There were three essential factors that made it possible for the practical engineer to put the program over. The first factor was that the management gave the new personnel manager a free hand and did not require him to keep a lot of records until the program was in full force. The second factor was that the management called their foremen together and outlined the full program and requested each foreman to take a personal interest in the project. The third factor deals with the practical engineer in the role of a personnel manager who followed only the laws of common sense instead of complex theories on how to keep employees informed of developments and in a pleasant way cause them to work efficiently. Probably the best way to discuss the procedure is to tell step by step how the practical engineer went about selling the program to his fellow employees.

The management gave the practical engineer a two weeks' notice that he would take over the duties of personnel manager and outlined the object of the "experiment". During the following two weeks the practical engineer mapped out the following program and, what's more, it was carried out!

Realizing it was going to take some showmanship on his part to put the "Better Employee Relation Program" over, his first move was to have the frosted glass removed from the personnel manager's office door while several employees were standing in the hall. His next move was to start at the top of the employee's list and post on the five bulletin boards in the plant the first ten names of employees and cordially invited them to stop in the office at their convenience.

In order not to inconvenience any of the men in making the informal call, the personnel manager was in his office an hour before and an hour after the three shift change times and an hour before the day labor went to work. Strange as it seems, the P. M. shook hands with each man as he entered the office and instead of confronting the man with his personal record he kept his desk clear of all papers other than a clean pad. After the usual conversational salutations, the P. M. inquired if the visitor had any suggestions to offer for plant or personnel improvement. Each of these suggestions, regardless of its value, was carefully tabulated. The visitor was permitted to discuss any other subject he chose to and talk as long as he wished.

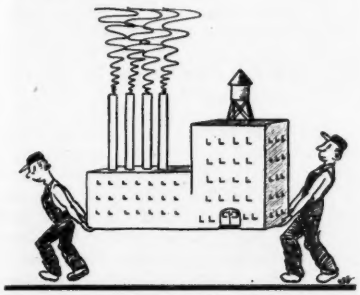
Before the conference ended the P. M. had collected vital statistics concerning the employee's family, the children's ages and his chief interests and hobbies. Before the visitor left, the P. M. inquired casually whether it would be agreeable to the employee and his wife if he and his wife would drop in some evening for an informal call while they were out driving. A hesitant answer was usually recorded on the note as "No", while a friendly "Yes" was answered with an informal call as soon as possible. The above procedure was followed until every one of the 300 employees had been personally contacted. The results were instructive and aided in mapping out the future program.

The next step was to assemble the foremen and management and impress upon them the fact that when a man made an error he was reprimanded for it, hence when he does a good piece of work he should be complimented for it. The management agreed to send a letter of appreciation to each man recommended by his foreman for meritorious work, regardless of whether it is ditch digging or a technical discovery. These letters are all signed by the company superintendent. As a point of interest it has been proved that approximately 30 other employees read the letter of appreciation.

As the program progressed and the temper of the employees was determined a more general program was adopted. To assist with the program the company had a nicely bound note book printed and the company manager personally presented one to each man who had been employed for one year

*This article was written in response to a request published on page 40 of the January issue under the title "How to Keep Posted." A number of other comments have already been received and will be published later under the title "Keeping Posted" in the Questions and Answers department. This particular reply covered the subject so concisely and thoroughly that it was changed to a more prominent position. The author is not a professional personnel man, but a fuel conservation engineer whose avocation is human relations. It is recognized that a frank and open expression of opinion on this subject may entail unpleasant consequences for certain individuals. Under the circumstances arrangements can be made to publish acceptable comments anonymously but we must know the name, address, title and company connection. Upon request this will be kept confidential.

or more. The book contained a pocket for the safety card inside the front cover, the first three pages gave safety rules and the next two contained the Seven Fundamentals of First-Aid. The rest of the book contained descriptive material, tables, dimensions of materials, and data relative to the plant's products and maintenance. This manual met immediate approval and the men are referring to them every day in laying out their work.



—they carry their jobs home

For the P. M. to act as liaison officer between the management and employee it was necessary to know the type of work each man in the plant was doing, so he started a personal tour visiting each department, spending from half a day to a week in each. This better equipped him to answer the management's questions on promotions demotions or the attitude of various men toward work. Three months spent meeting the employees on "common grounds" brought some criticism from the management, but has since proved that results would warrant a year so spent.

The next move was to make the men familiar with the cost of the materials they handled daily. This was accomplished by installing five simple display cases at strategic points in the plant. Three times each week four articles were placed in the show case and a large card carrying the catalog name and exact cost of the article was placed behind each one. Such articles as water hose and rubber gaskets were shown in certain sizes or lengths.

Not long after the cases were installed, it was common to hear a workman pick up a piece of material and say, "Here's so many pennies." Several times orders for material have had rough estimates of cost penciled on them and more noticeably quite a few jobs have shown better planning and hence a lower material cost since the instruction book and cost display was started.

To get the employees more interested in their work the personnel manager requested the management and all the engineering department to send him all the descriptive literature of materials and products, magazines, and even advertising material. This information is sorted and interesting articles are fastened into folders. Names of the men thought to be interested in a certain article are written on the front of the folder and then the P. M. personally delivers the folder to the first man on the list, explaining when he has finished the article to pass it on to the next man. As extra display, safety slogans were written on the folder. The system has become so effective that the practical engineer has loaned out numerous books and some of the questions have become so technical the man had to be referred to the chief engineer.

The P. M. believed suggestions turned in by the employees would prove to be the barometer of the progress of the program. When men start turning in suggestions they are carrying their jobs home, hence they are developing a feeling they are part of the company.

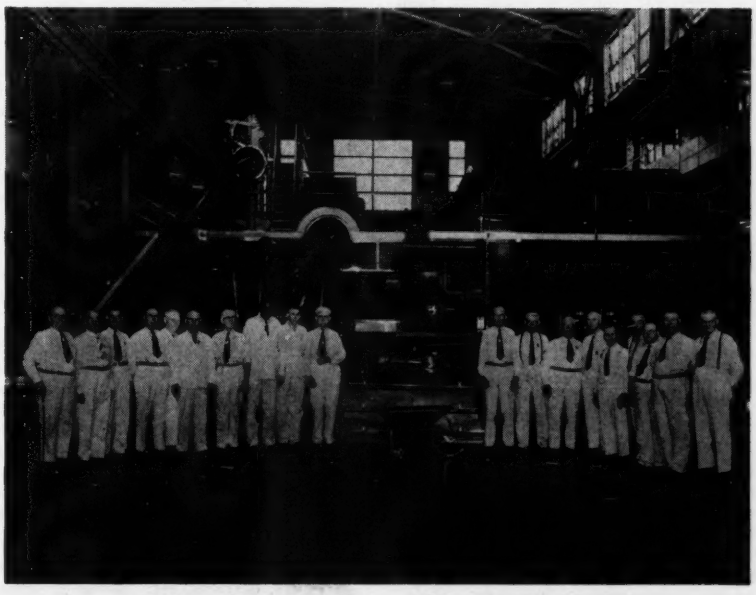
Realizing the health of an employee and his family is the most essential fundamental of efficient work, the personnel manager scans the daily paper for any clew of an employee's sickness. Names are jotted down and the employee is personally contacted the next day. In this connection the P. M. has obtained hospital rates from several hospitals, the names of recognized medical specialists in the district, a list of nurses and a list of employees who are willing to donate their blood free in case of an emergency transfusion.

It has been found that it is a very poor policy for a personnel manager to advise on financial questions. He has found it is better to direct the employee to a banker or Better Business Bureau.

An "open house" is kept by the P. M. at all times. Employees have the privilege of entering his office or home at all hours of the day or night, since the entire program depends on personal contact with employees.

In conclusion it must be said 98 per cent of this program depends on the support of the management in putting a program like this over, only two per cent on the effort of the P. M. It takes regular meetings of the management, foremen and P. M. to discuss employee relations and each individual must cooperate to the limit to make any program agreeable to employees. After all any improvement in employee relations benefits them more than it does the management, for it increases company profits and the larger the profits the more job-insurance the employee is assured.

The practical engineer was chosen to take the part of the personnel manager because his common sense and contact with men has made him a practical engineer, instead of just an engineer.



Henry Ford's Power House Seniors

LINED UP in front of one of the big generators at Ford's Rouge plant in Dearborn, Mich., the youngest of the Power house group shown here is 68 and the two senior members are 86. The aggregate age of the 19 is 1406 yr., an average of almost 75, and all of them with first hand knowledge of the originals of the chromium-plated scoop and wheelbarrow now only souvenirs of the old days. Reading from left to right the men, are: Wolott Facherell, 71, Elevator Operator; John Whitty, 69, Pump Operator; Jack Hamilton, 73, Engineer Blower Room; Bert Maddock, 70, Coal Conveyor Operator; Chas. Litegot, 86, Elevator Operator; Tony Polk, 78, Electric Repairman; George Floyd, 75, Operator Chlorinating Water; Wm. Perry, 86, Cleaner; Peter Short, 70, Pump Operator; John McCabe, 76, Chemist; H. Keen, 72, Elevator Operator; Fred Merton, 72, Janitor and Relief Elevator Operator; Vincent Consiglo, 74, Cleaner; Henry Menager, 68, Chemist; George Siegal, 78, Cleaner; Frank Daniels, 70, Pipefitter Foreman; Hugh Hamilton, 72, Engineer Blower Room; Robert Swirles, 70, Millwright and Louis Pengeot, 76, Elevator Operator.

Wire Rope Inspection

By W. Elwood Rossnagel, Safety Engineer
Consolidated Edison Co. of New York, Inc.

ONE OF THE difficult problems confronting the engineer is that of deciding just when a wire rope has reached the limit of its safe usage and must be discarded. Naturally, it is poor economy to discard an expensive hoisting rope before it is necessary. Likewise it is dangerous, and may also prove expensive, to continue its use beyond a certain stage.

To determine the proper time to condemn the rope a careful inspection should be made not only of the rope itself, but also of the sheaves and other parts which affect its use. Some of these factors are as follows:

1. CONSTRUCTION OF THE ROPE. This includes the diameter, number of strands in the rope, number of wires in each strand, quality of the steel, Warrington or Seale lay, regular or Lang lay, right or left lay, ordinary round or flattened strands, hemp or wire strand or independent wire rope center, preformed or non-preformed. If the rope is of a type or size not suited for the use, this fact should be taken into consideration. Several of these items can only be ascertained from office records.

2. BROKEN WIRES. The total number of broken wires in all strands within a distance of one rope lay (the distance in which a certain strand makes one complete turn around the rope) at the worst portion of the rope are taken as an index of the reduction in strength due to this cause. In inspecting preformed rope extra care should be exercised as the broken wires lie flat in position and are often difficult to detect.

3. LOCATION OF WIRE BREAKS. It should be observed whether or not several adjacent wires are broken, whether the breaks occur at the point of tangency with the sheave groove or with the adjacent strands, whether the breaks are about equally distributed among the strands or are mostly located in a few strands. Unequal distribution of the breaks results in a greater loss of strength than when the same number are equally distributed.

4. WEAR ON OUTSIDE WIRES. The length of the shiny, worn spots on the outside wires should be observed, as this is an index of the reduction in area, and likewise in strength, of the wires and of the rope, due to wear.

5. RESERVE STRENGTH. This factor is determined from the data obtained under Item No. 1 above, and is the ratio of the area of all the inside wires to the area of the rope. In other words, in case of failure of all the outside wires, the strength of the inner wires should remain as a reserve. Seale lay ropes have the lowest reserve strength and 37-wire-strand ropes the highest.

6. CORROSION. Ropes which have been neglected and are badly corroded on the outside may reasonably be assumed to be in a somewhat similar condition inside. The effect of corrosion however is very difficult to estimate with any degree of accuracy.

7. KINKS. Kinked portions of the rope should be carefully examined, as wear and wire failures occur early at such locations due to the unequal distribution of the load on the several strands and to the binding of the rope in the sheave grooves.

8. CRUSHED STRANDS. These should be carefully inspected for wear and broken wires, for the reasons given in Item No. 7 above.

9. HIGH STRANDING. In such a case, one or more strands are forced out of position and give the rope a cork-screw appearance, resulting in unequal distribution of stress and excessive wear. This will result in premature failure of the rope. Such a condition is usually the result of improper socketing or clipping.

10. BIRDCAGING. This is most common in Lang lay rope and is usually the result of improperly installing the rope, or of inadequate seizing.

11. PITCH OF ROPE LAY. The pitch of one rope lay of a used rope should not differ materially from that of a new rope. In some cases, due to improper sheaves, that portion of the rope which passes over the sheaves will have its lay increased, the twists being accumulated at the ends of the rope as evidenced by the shortening of the lay at these points.

12. TURNS IN THE ROPE. In the case of hoists, derricks, etc., having multiple reeving of the rope in the pulley blocks, the rope during its early life will stretch and unlay slightly, causing the load block to rotate and the ropes to twist around themselves. In such a case the end of the hoist rope, whether at the load block or boom head, should be detached and rotated so as to remove the turns. In the case of a new rope, a few more turns than are necessary may be made in the rope in anticipation of the subsequent stretch of the rope.

13. FREQUENCY OF USE. The number of hours per day or week during which the rope is in use is an important factor. The inspector should consider how much use, and depreciation, a rope will have before the next inspection. In other words, consider two ropes in identical conditions and under similar loads. One rope is used only an hour or so a week and probably will be safe for use at least until the next inspection, while the other rope which is in use eight hours a day will probably be in a dangerous condition before the next routine inspection. Therefore, the much used rope should be condemned while the other may be accepted for further use.

14. ROPE SPEED. A high-speed rope will have a much shorter life, and also expectancy of life, than a slow speed rope, and therefore should be given a more severe inspection.

15. ROPE BEND. The number, size and alignment of sheaves and drums should be taken into consideration. Also any reverse bends; and the spacing and size of the sheaves causing this condition should be particularly noted. All ropes operating under such conditions should be condemned at the early signs of failure as they are probably badly fatigued. A rope should not be operated on a sheave having a mean diameter less than 16 times the rope diameter (assuming a 6 x 19 Warrington lay rope). A ratio of 24:1 is preferred, and 30 to 50:1 is ideal.

16. SHEAVE AND DRUM GROOVES. These should be inspected for corrugations or wear, such as will pinch a new rope which will be slightly larger in diameter than the worn rope.

17. SUDDEN LOADS AND SHOCKS. Investigation should be made of the acceleration and decelartion rates, the probability of jerks, sudden takeup of slack, whipping, etc., as these aggravate fatigue of the rope.

18. EQUALIZING SHEAVE. On a hoist or crane upon which an equalizing sheave is provided, especially when its diameter is less than about 16 times the rope diameter, that portion of the rope which bears upon this sheave should be carefully examined. Frequently, broken wires are found at the equalizing sheave while at the same time the portion of the rope running over other sheaves is in very good condition.

19. MULTIPLE WINDING ON DRUM. Where more than one layer of rope is wound on a drum, special examination should be made for crushed strands at that portion of the rope where pinching takes place against the drum flange at the end of the layer of rope.

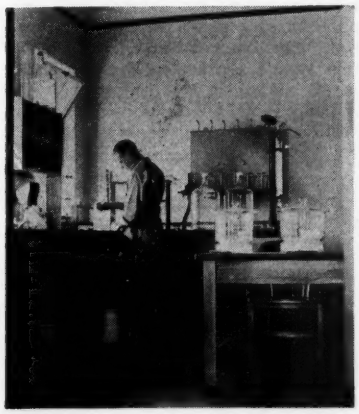
20. PERSONAL AND PROPERTY HAZARD. Consideration should be given to the possible consequences resulting from failure of the rope, especially where men are hoisted, as in elevators or mine cages, or where heavy loads are carried above men or valuable machinery.

21. ORIGINAL SAFETY FACTOR. Where a liberal factor of safety had been allowed when the rope was new, naturally a greater depreciation may be allowed than if a low initial safety factor had been used.

(To be concluded in the May issue.)

Plant Laboratories

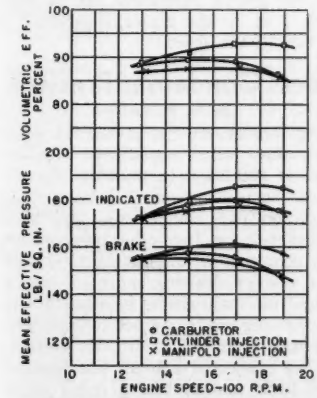
IN MANY PLANTS an accurate check of water conditions is necessary and this requires laboratory facilities. In many cases a few test tubes, flasks, burettes, filters and a few simple chemicals are sufficient for routine tests. A number of companies sell



low priced kits or cabinets which can be used as a test laboratory in some convenient corner of the plant. In other plants the needs are such that a more complete laboratory is necessary. The one illustrated is the plant laboratory in the sewage treatment plant at La Crosse, Wis., described in the September 1938 issue, page 571.

Which Fuel System?

WHILE DIESELS using heavy fuel are limited to injection of the fuel direct to the cylinder, engines using lighter fuels have the choice of three methods: a carburetor; manifold injection; and cylinder injection. Considering the higher cycle efficiency of the Diesel there has always been some question as to whether or not fuel injection might not have advantages over the carburetor as commonly used with the engine using light fuels. This question has been quite thoroughly answered by a series of tests completed last year at Langley Field (N. A. C. A., TN No. 698) on a single Wright 1820-G air cooled cylinder.



Variation of engine power and volumetric efficiency with engine speed. Fuel-air ratio, 0.08

Each method of mixing the fuel and the air was investigated over a range of fuel-air ratios from 0.10 to the limit of stable operation and at engine speeds of 1500 and 1900 r.p.m. The comparative performance with a fuel-air ratio of 0.08 was investigated for speeds from 1300 to 1900 r.p.m.

For the range of fuel-air ratios from 0.10 to about 0.06, the minimum specific fuel consumption is the same for each of the three methods of air-fuel mixing tried. The engine equipped with a carburetor runs smoothly on the leanest mixture, its performance being slightly better than with fuel injection into the cylinder and considerably better than with manifold injection.

Although these tests indicate practically no difference in performance with each of the three methods of mixing the fuel and the air except for the gain in power at high speeds with fuel injection into the cylinder, other important factors govern the selection of a fuel system. When a less volatile fuel, such as "safety fuel," is used, the carburetor would be unsatisfactory and the best performance would be obtained by direct injection into the cylinder.

When an engine is operated with valve overlap, fuel injection into the cylinder must be employed or else some fuel will be wasted in scavenging the clearance volume. With fuel injected into the cylinder, no difficulty should be experienced with icing.

For instance, tests on multicylinder engines have shown that better starting, acceleration, and maneuverability can be obtained with fuel injection. Well-designed fuel-injection systems give almost perfect distribution of fuel between cylinders. At engine speeds between 2000 and 3000 r.p.m., the variation in distribution at full load and part load is less than 1 per cent.

Combustible Gas Alarm Assists in Boiler Control

By Ray Winters
Results Engineer
Northeast Station

Editor's Note: For some time a combustible gas instrument has been in service at Northeast Station. This instrument has been found useful, particularly when starting up the boiler on gas fuel for it gives added assurance against furnace explosions and secondary combustion.

AT NORTHEAST STATION, of the Kansas City Power & Light Co., a Mine Safety Appliance Type I-2 Combustion alarm has been installed in a large boiler to help prevent gas explosions and secondary combustion. The boiler is equipped to burn pulverized coal, natural gas or fuel oil and for this reason it was thought that unbalanced conditions might occur. This combustion gas alarm is a continuous sampler of the type usually used as a warning of various percentages of explosive air mixtures in factories, mines, etc.

An individual sampling line is used. It has a Carborundum filter located in the gas duct between the economizer and the air preheater and is connected to the instrument with 40 ft. of ½ in. pipe. Since the instrument fan produced only 0.6 in. of draft, it was necessary to install a return line from the exhaust to the gas duct in order to maintain a flow of gas.

The instrument registers only combustible material in per cent of the amount required for an explosive mixture and the alarm can be set to ring at any desired mixture up to 60 per cent of the low explosive limit. We normally set the alarm for 20 per cent of low explosive limit. Since the scale is calibrated in terms of some individual gas it will be slightly in error if another combustible material is in the sample.

Use of the instrument for combustion control is limited to extreme conditions and of course only where there is a shortage of air. It will not register excess air as that is its zero setting. It has also been found that the zero setting can be varied by changing the pressure, temperature, and moisture content of the air used for setting.

It was not, however, installed for combustion control but to give an alarm when the gases contained excessive unburned fuel and it has performed this duty satisfactorily. The alarm has sounded on occasions usually when changing from one fuel to another.

Keeping Frozen Bearings in Service

By Frank E. Saari
and
Eugene George Key

REPAIRMEN of rotating machinery have all had to contend with frozen bearings which often mean long delays and expensive shutdowns. A frozen bearing may be defined as a tight frictional grip, amounting almost to a weld, between the shaft and bearing.

It is caused principally by low oil level, oil ring not turning, oil getting gummy from age and dirt, or by use of the wrong lubricant. These possible sources of trouble should be watched carefully and avoided as much as possible. A repairman in a large plant, however, cannot spend every minute of his time gawking into oil reservoirs and something may happen between inspections that cause the bearing to freeze.

There is an emergency treatment that can be applied in a very few minutes and make the bearing serviceable for a week or even longer until the machine or line shaft to which the motor is connected can be shut down and the permanent repair made. This treatment consists of the following few simple directions:

1. Drain all the oil from the bearing. This oil is probably so hot that it prevents the cooling of the bearing and so gummy that it does not have

the penetrating properties required.

2. Fill the oil reservoir with a low viscosity liquid such as kerosene, gasoline, naphtha, alcohol, or paint thinner. This liquid must be light so that it will penetrate even small separations between shaft and bearings.

3. Remove all connections between the motor shaft and load, but if a belt drive is used, do not remove the pulley. If a gear drive is used, the gear on the motor shaft may have to be removed.

4. If the motor is of low horsepower rating, the repairman may be able to free it by hand, using the pulley to get the leverage necessary to turn the shaft. If the motor is too large or if the bearing is frozen too tightly, a pipe wrench should be used. Tighten the wrench jaws around the pulley and turn the armature shaft in any convenient direction, preferably in the normal direction of rotation of the motor. The strength of two men may be necessary to free the bearing. When it is freed, continue to turn the shaft, first in one direction and then in the reverse, making sure that the motor is turned at least one complete revolution before reversing its direction unless the bearing starts to tighten up before the revolution is completed.

5. Work the motor shaft in this manner for several minutes and then drain the liquid, refilling with new liquid of the same kind. Then continue to turn the armature (or rotor, in an a.c. machine). The bearing may have to be treated several times with cooler liquid until the housing feels cool to the touch of the hand. When it is cool, mix a little oil with the liquid and turn the motor a few more times. It will then usually start to turn freely, but if it does not, drain and refill with the same liquid, adding a larger amount of oil. About three refills of the thinner liquid and one oil-liquid mixture is usually sufficient during the treatment.

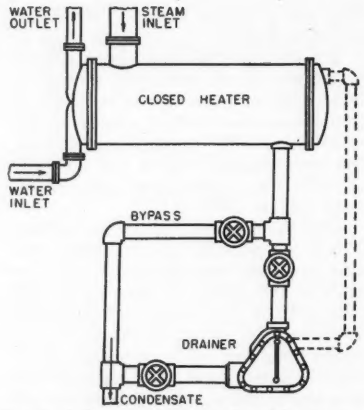
6. When the motor turns freely enough to put into service, drain the oil-thinner mixture and fill the reservoir with clean, unused oil of the proper consistency. Try the motor without load first, and if it runs satisfactorily, it can be put into service. Check the oil ring.

The time of the complete treatment will usually be about 20 min. if two men work together on it. Production schedules are not, then, as seriously interrupted as they would be if the motor were taken out and replaced at the time, and the savings thus effected will usually more than finance the repair work that can be done at night or over the week end when the plant is not in operation.

Draining Closed Heaters

By S. D. Distelhorst
Cochrane Corp.

IN DRAINING a closed heater or other vessel where condensate must be discharged quickly and in large quantities, the rush of water to the drainage unit may cause steam binding, thus preventing the discharge of condensate at the rate



Standard drain hook-up on closed heater indicating location of equalizer connection from drainer back to steam space to prevent steam binding under surge loads

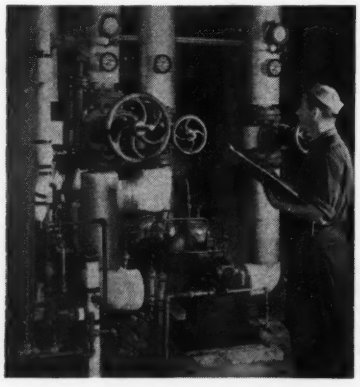
for which the unit is designed.

Enlargement of the piping to the drainage unit will help relieve this condition but, better still, installation of an equalizer connection back to the steam space of the vessel drained will relieve uncondensed steam and permit free flow of the condensate.

In the hook-up illustrated, the by-pass is installed only as a means for taking the drainer out of service long enough to inspect its operation. Drainage equipment should not be selected with such limited capacity that the by-pass valve must be used as means of manual control during peak load operation.

Put Gages Where They Can Be Read

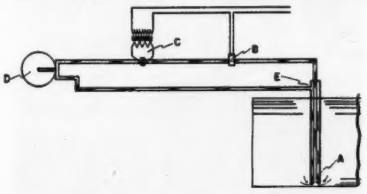
WHERE EFFICIENT OPERATION, with accurate regulation is desired, instruments are necessary. Unfortunately these instruments are not always located where they can be used to maximum advantage and as a result do not give the results expected. Instruments are intended to serve as a guide to the operator and must be located where they can be read without undue effort. The photograph shows a carefully laid-out installation of Weston dial type thermometers in the boiler room on pipe lines which circulate hot water through the jackets of hydraulic molding machines. Slightly above eye level, on the near side of the pipe,



with no light glare, they can be read by the operator easily for purposes of temperature regulation or for the plant log.

Heating Oil Electrically

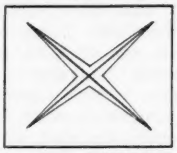
IN MANY INDUSTRIAL applications the ease and simplicity of electric heating makes it a prime favorite especially in locations where the expense and complication of a steam heater is not justified. The Lines thermal electric induction system for heating viscous liquids is of interest in this connection. The drawing shows the application to a return fuel oil system using Bunker C or No. 6



fuel oil. Oil entering the central pipe at A is heated as it slows to the point of use D and also as it returns to the tank through the special head E. (Oil pump not shown). Electrical energy is supplied through a special heavy duty transformer C to the pipe system which acts as the transformer secondary. Temperature regulation is by means of the thermostat B acting through the transformer secondary. The same principle is often applied to thawing frozen pipes.

Ducts and Breechings

THIN SHEET METAL used in the construction of air ducts and breechings has a tendency to warp and buckle unless adequately supported. This is difficult to do without complicating the construc-



tion unduly and materially increasing the cost. The sheets may, however, be made self-supporting by grooving on both diagonals, as shown by the sketch, sufficient to give a permanent set of from ½ to 1 in. in the center, depending on the size of the sheet.

Excess Condenser Pressure

By G. F. Suchy

AT OUR PLANT the layout of equipment and other conditions involved make it necessary to maintain the ammonia suction pressure below atmospheric on two compressors and above atmospheric on two other compressors. The compressors on low back pressure were always drawing more or less air around the main shafts because the special packing rings are set to hold pressure only from the inside. To overcome this we connected a small line from the high back suction line to each of the low back compressor crank cases. Since then the excess condenser pressure has been negligible.

Questions And Answers

Foundations

WITH AN ENGINE belted to a generator and the engine and generator foundations separate, would it be advisable to set the engine foundation in cork board to eliminate vibration, or, would the cork spring enough to throw the belt out of alinement?

LELAND KENOGY

Newton Ice Co.
Newton, Kans.

WE generally recommend the installation of the driving engine and driven generator on a common foundation block in order to prevent misalinement and in order to prevent difficulties with the belt drive. Although the deflections of organic materials under engine foundations are very slight, it is our past experience that separate foundations have not proved satisfactory.

DR. K. KLOPSTOCK

The Korfund Co., Inc.
New York City

Series and Parallel Operation of Centrifugal Pumps

IN THE DECEMBER issue, page 804 under Questions and Answers, the writer has found an error in regard to the operation of centrifugal pumps in parallel. You state that if one pump gives 250 g.p.m. at 50 ft. t.d.h., then two pumps will give 500 g.p.m. at 50 ft. t.d.h. If one pump is operating and gives 250 g.p.m. against 50 ft. t.d.h., two pumps will not give 500 g.p.m. but some capacity between 250 and 500 g.p.m. depending on the system head curve.

West Orange, N. J. H. E. CHASE

MR. CHASE IS of course right if the pumps are considered in relation to the entire pumping spstem. At the same time the original answer is correct insofar as the pumps alone are concerned at constant efficiency, a condition set by other questions of L. W. D. but not apparent from the single question used on page 804.

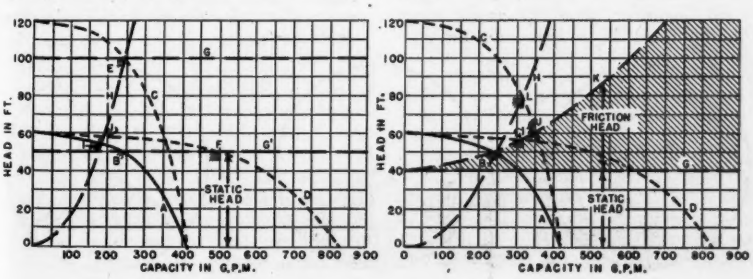
The head-capacity characteristics of a pump can be estimated closely by the designer or may be determined from tests. In the shop this is done by creating an artificial head by throttling the discharge valve. From a number of simultaneous head and capacity measurements a curve similar to A of Fig. 1 is obtained. The design operating point B is usually selected at or near the point of maximum efficiency. Two similar pumps in series would act as a two stage pump and give an equivalent characteristic as in Curve C. The same two in parallel would act as a single pump with twice the capacity and give an equivalent characteristic similar to D. Thus if two pumps in series were delivering 250 g.p.m. against a 100 ft. head, Point E, one of them would be pumping 250 g.p.m. against 50 ft. head, Point B, and under the same conditions and efficiency two in parallel would deliver 500 g.p.m. agaainst 50 ft. head, Point F.

In practical operation the system head would have to be taken into consideration. If only a static head were involved, conditions closely approximated in some low head irrigation projects pumping from one canal to another, the head would remain practically constant at all flows as shown by line G of Fig. 1. Under this condition one pump alone or two pumps in series would not develop sufficient head to pump any water.

On the other hand, if the head were entirely due to pipe friction, it would vary approximately as the square of the velocity (or capacity) as shown by curve H. The capacity delivered by a single pump or by two pumps in series can be found where the system head curve H crosses the pump characteristic, at I and J, 190 and 195 g.p.m. respectively for single and parallel operation. Thus two pumps in parallel would deliver only a trifle more water than one pump operating alone and much less than the rated capacity of 250 g.p.m. The efficiency would be much lower. Line G^1 added to Fig. 1 shows the operation of one pump alone or two pumps in parallel for a constant static head with negligible pipe friction.

Pipe friction, however, is an ever present condition and Fig. 2 shows operating conditions, with the normal head Point B, is made up of 80 per cent static head and 20 per cent friction head. The static head remains nearly constant at all flows, the friction head varies as the square of the flow is indicated by the shaded area. The total head is shown by curve K. One pump would deliver 250 g.p.m., Point B, two in parallel 315 g.p.m., Point I, and two in series 350 g.p.m., Point J. It is apparent as Mr. Chase says that the question can be answered completely only by considering the system head.

The abbreviations t.d.h. used by Mr. Chase mean total dynamic head, an advisable precaution when speaking of centrifugal pump performance in order to avoid misunderstandings as to just what is included in the head.



Pipe Size

CAN YOU give me a simple rule or formula for finding the size of a steam pipe, specifically the answer to the question: What diameter of steam pipe is needed to transmit 5000 lb. per hr. of 10 lb. ga. steam 100 ft. at a velocity of 4500 ft. per min.? A. A.

WHEN the velocity is given the pipe size can be determined from the simple equation

$$Q = A V$$

Where Q is the flow in cubic feet per min., A the internal area of the pipe in sq. ft. and V the velocity in ft. per min. It is necessary to determine the specific volume of the steam from tables, in this case about 16.50 cu. ft. per lb. The flow is $5000 \times 16.5 = 82{,}500$ cu. ft. per hr. or 1375 cu. ft. per min. The pipe area therefore must be $Q/V = 1375/4500 = 0.305$ sq. ft. This necessitates an internal diameter about 7.5 in. which is a trifle less than a standard 8 in. pipe which would, therefore, give a velocity slightly lower than 4500.

While it is simple to find the pipe size when the velocity is given, the determination of a safe velocity and reasonable pressure drop requires considerable experience and judgment. Velocities range from: 4000 to 6000 ft. per min. for low pressure saturated steam lines, and should be lower in order to minimize the effect of vibration and possible water hammer where there are pulsations and with lines which are long and difficult to drain: 6000 to 8000 ft. per min. for medium pressure saturated steam lines for engines or general heating lines; 10,000 to 15,000 ft. per min. for superheated steam lines and turbine leads; to as high as 50,000 to 75,000 ft. per min. for district heating lines in exceptional cases where high pressure losses are permissible as in feeder lines to outlying distribution centers.

Velocities should also bear some re-

WATER HEATER CONNECTIONS

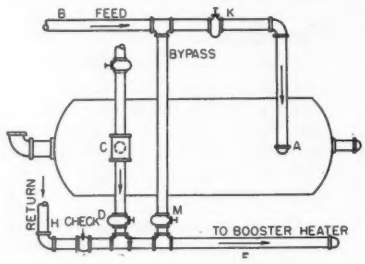
IN REMODELING our steam and water piping a few years ago the engineer in charge of the work apparently showed poor judgment for we have trouble with the hot water, not in the heating but in the circulation. We have two heaters, the one shown in the sketch has a capacity of 100 gal., the other of 1000 gal. The water in the smaller one passes through a coil and is discharged into the larger one and from there to the rooms in the house. The water is heated in the small one by exhaust steam and can be boosted in the 1000 gal. unit.

The size of the pipe is as follows: the diameter of the pipe on the outlet from the 1000 gal. unit is 2-in., 20 ft. long reduced to 1½ in. with 30 ft. of this smaller pipe on the ceiling of the boiler room floor. Risers from the 1½ in. pipe are 1 in. run up to the seventh floor, 80 ft. above the basement. The return pipe is ⅜ in. and 50 ft. long, enlarged to ¾ in. diameter for 30 ft. and then to 1 in. for 30 ft. just preceding the small heater.

Direction of the water flow is as follows on the sketch: City water enters through pipe B. After being reduced from 100 to 81 lb. it passes through valve K and enters the heater at A. Passes through the coil and comes out through tee C, through valve D and pipe E and flows to the 1000 gal. heater. At F there is a 1 in. check valve but at the tee at P the size is increased from 1 to 1½ in.

Water in the system returns through pipe H and is supposed to pass through the check at F, meeting the city pressure of 81 lb. at P. I put a gage on the pipe at H and the return pressure is only 64 lb. We are thinking of putting in a circulating pump. Perhaps some other engineers have had experience along this line and can suggest changes, or at least tell me how large a pump is needed as well as how and where it should be connected.

W. A. D.



lation to the pipe size and it is not considered good practice to exceed from 800 to 1000 ft. per min. per inch of diameter, the lower values to be used with the smaller size pipes. The higher the velocity, the lower the pipe size, pipe cost and radiation losses. The pressure loss increases, however, as the velocity increases. In spite of the work which has been done on pipe friction, calculation of pressure loss is rather problemmatical because of the variable effect of elbows and bends.

The chart on the last page of P. E. & E. can be used to calculate pipe sizes, velocities and pressure drops. When using this chart work the problem in the order shown by the numbers in the small key diagram, and use the vertical lines marked SU, A and K. That is first find the pressure and temperature point and carry this horizontally to the left hand line marked SV where the specific volume can be read direct if desired. Similarly on the two outside scales, locate the proper size and weight of pipe and follow the guide line into the A or K axis as the case may be. Calculations should always be based on the intersections with these axis which, while the units are not marked, are based on the actual inside diameter and friction coefficient respectively. The different pipe sizes are carried out to the respective black dots, in order to separate and make easy the identification of different sizes and weights of pipe.

Cylindrical Tanks

On page 740 of the November 1939 Power Plant Engineering is a chart for graphically determining the content of cylindrical tanks. I do not understand the formula which is given in the upper left corner, which says that the area of the segment is $R^2 \text{ Cos}^{-1} (R\text{-}H)/R - (R\text{-}H)\sqrt{2\,RH\text{-}H^2}$

I was taught to read $\text{Cos}^{-1}(R\text{-}H)/R$ as the angle whose cosine is $(R\text{-}H)/R$, but I do not understand how that could be used in the formula.

Lakeland, Fla. E. V. Erickson

Your understanding of the term Cos^{-1} is correct and the angle whose cosine is $(R\text{-}H)/R$ is substituted directly in the equation. It should have been noted, however, that the angle must be expressed in radians, an angular measure used by mathematicians instead of degrees. There are 2π radians in a circle so one radian is equal to $360 \div (2 \times 3.1416)$ or 57.3 deg.

The development of the formula is as follows in which, as shown by the sketches: a, is the central angle in radians; R, the radius in feet; H, the height of the segment in feet.

$$\text{Area of entire circle} = \pi R^2 \quad (1)$$

There are 2π radians in a circle so

$$\text{Area II} = (a/2\pi)\,\pi R^2 = aR^2/2 \quad (2)$$

By definition the cosine of an angle is the adjacent side of a right triangle divided by the hypothenuse and by inspection of Fig. 2.

$$\text{Cos}\,(a/2) = (R\text{-}H)/R \quad (3)$$

Then

$$a = 2\,\text{Cos}^{-1}\,(R\text{-}H)/R \quad (4)$$

Substituting Eq. 4 in Eq. 2

$$\text{Area II} = R^2\,\text{Cos}^{-1}\,(R\text{-}H)/R$$

Area III is a triangle and the area is one-half the base times the altitude. The altitude is R-H and the base, as determined by the theory of right triangles, is

$$2\sqrt{R^2 - (R\text{-}H)^2} = 2\sqrt{2RH - H^2}$$

Therefore Area II is

$$= \tfrac{1}{2} \times (R\text{-}H) \times 2\sqrt{2\,RH - H^2}$$

$$= (R\text{-}H)\sqrt{2\,RH - H^2}$$

By inspection it is evident that

$$\text{Area I} = \text{Area II} - \text{Area III}$$
$$= R^2\,\text{Cos}^{-1}\,(R\text{-}H)/R - (R\text{-}H)\sqrt{2\,RH - H^2} \quad (6)$$

Inasmuch as 2π radians $= 360$ deg. the equations may be worked out with the angle "a" expressed in degrees instead of radians, more convenient for practical use with the usual tables. If A is the central angle in degrees

$$A = 2\,\text{Cos}^{-1}\,(R\text{-}H)/R \quad (7)$$

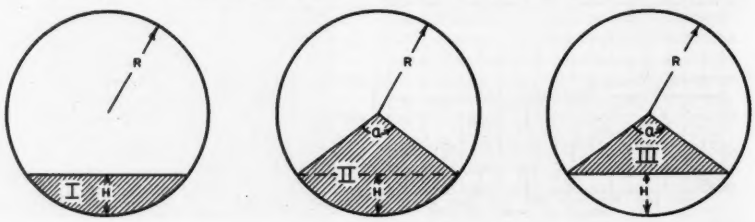
and as before Area I

$$= (R^2/57.3)\,\text{Cos}^{-1}\,(R\text{-}H)/R - (R\text{-}H)\sqrt{2\,RH - H^2} \quad (8)$$

As an example take a 48 in. diam. tank with 12 in. depth of water. Then in feet $R = 2$ and $H = 1$. Using Eq. 6

$$\text{Area I} = 4\,\text{Cos}^{-1}\tfrac{1}{2} - (2\text{-}1)\sqrt{(2\times2\times1) - 1}$$
$$= 4 \times 1.047 - \sqrt{3}$$
$$= 2.45 \text{ sq. ft.}$$

It is necessary to use natural cosine tables, looking down the tables until the cosine 0.5000 is located and then reading the corresponding angle as 1.047. Many handbooks (for instance on p. 117, 23rd Edition, Handbook of Chemistry and Physics and Table XI, p. 194 of Burlington's Math. Tables and Formulas) have tables with the trigonometric functions in radian measure. More, however, have only the angle in degrees. If this is the case the



angle 60 deg. corresponding to 0.500, must be divided by 57.3 to get the radian measure which is 60 ÷ 57 3 = 1.0472.

When only these tables are available they may be used direct by means of Eq. 8. Substituting in this

$$\text{Area I} = (4/57.3)\ \text{Cos}^{-1}\ ½ - (2-1)\ \sqrt{2\times 2\times 1)-1}$$
$$= (4/57.3)\ 60 - \sqrt{3}$$
$$= 2.45 \text{ sq. ft.}$$

The equation being for the area of a segment of a circle gives the desired area covered by the water from zero up to the center of the tank. Above the centerline the method must be reversed and H taken as distance not covered by the water, that is the distance from the water to the top of the tank. The area calculated from the formula must, therefore, be subtracted from the total area of the circle to give the desired result. A formula could be developed but would serve no useful purpose because the values calculated for different depths in the lower half can be used directly in carrying on calculations for the upper half. After the areas are found the volume is of course the area of the end covered by water times the length of the tank. Thus while the calculation is not difficult, it is involved. The simplicity of the chart is apparent, and judging from the large number of favorable comments received, is appreciated by readers.

Cleaning Ammonia Condensers

SINCE READING the article by C. C. Collins, in the October issue p. 677 I am reminded that my best success in cleaning double pipe ammonia condenser tubes is to secure one of the small air driven tube cleaners, as manufactured by the Elliott Co., and run that through the tubes. Within a few hours all the tubes are cleaned. There is no difficulty from acid and after cleaning the gauge registers the proper figures and performance is up to par.

Another advantage in this method of cleaning tubes is that the tubes can be cleaned with no interruption of service. I find running this cleaner through twice a year keeps my condenser in perfect condition.

H. H. HOLMES
Chief Engineer,
Skipworth Packing Co.
Springfield, O.

Keeping Posted

REPLYING to the problem of R.L.J. (page 40 of the January issue) as to how to keep employees posted on new methods in different departments and to keep them interested, may I suggest the following:

Do not be a boss, but a friend without losing respect. Have monthly forums, get prominent speakers and invite employees to state their ideas. R.L.J. may serve a little lunch and refreshments, making it a sort of get-together.

Do not try to fool employees with fictitious reports, as many are not as dumb as their dirty overalls may indicate; many patents have been invented by the man on the bench.

Do not try to start a regular class educational system as many employees do not want to be forced directly or indirectly.

A bonus system may be worked out to good advantage, saving the employer many times the price of the bonus.

Having acted in the past as relations expert for plants employing up to 17,000 people, I would say that a lot depends on the size of the plant, and a few other things which one must know in order to start a program successfully.

Phillipsburg, N. J. W. HENNIG

Dry Ice

IN A RECENT ISSUE was an inquiry regarding the processing CO_2, which is an interesting subject. We understand that solidfied CO_2 is mined in Texas near the helium wells. That it is reclaimed in one of the largest distilleries in Peoria, Ill., by a technique with several interesting features. In Chicago the largest commercial producer of CO_2 uses coke in a specially designed furnace surmounted by a standard type of water tube boiler. The furnace has hand fired grates for burning the coke. They strive to keep 18 per cent CO_2 in their flue gases which run around 500 deg. F.

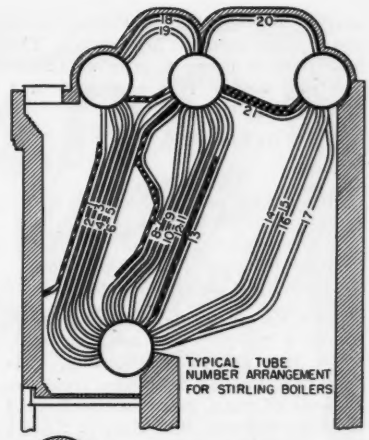
Gases from this boiler furnace are forced by induced draft through towers containing activated charcoal or coke. A solution of sodium carbonate is counterflowed through the towers and the reaction results in bicarbonate of soda. From these towers the precipitate is fed into lye boilers where in the presence of steam the precipitate is again split up into carbonate, CO_2 and steam. The steam is then condensed and the remaining CO_2 is compressed and liquefied in compressors, and pumped into bottles.

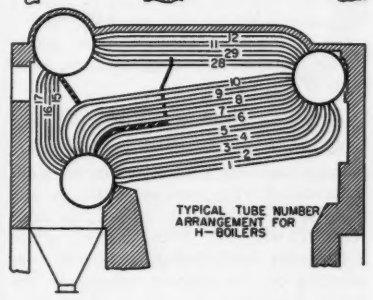
W. FREEMAN SMITH

Boiler Tube Numbering

WHERE is the No. 1 tube of a Stirling boiler located?
Detroit, Mich. L. W. D.

TUBES in the Stirling boiler, manufactured by B. & W., are in general numbered from the rear to the front, with the numbering continued from top to bottom between the rear and middle drum and finally from top to bottom between the middle and front drum. Thus No. 1 is the rear tube in the boiler and No. 17 (No. 16 if no slag screen is used) faces the furnace as shown by the drawing. This numbering arrangement is not followed exactly with all Stirling boilers, nor in general with other types of bent tube boilers. The second drawing shows the arrangemgent used for the type H boiler of the same company. There the No. 1 tube faces the furnace. We believe this second numbering arrangement approximates more closely the arrangement used by other manufacturers of bent tube boilers than does the first.





Coal Formulas

ON PAGE 738 of the November issue a question was asked about calculation of heating values from proximate coal analyses. Replies were printed on page 804 of the December and page 79 of the January issues.

Most engineers are skeptical of formulas for which they do not know the derivation and range of application. The following reply from Marvin A. Sayland, Brooklyn, N. Y., is therefore doubly interesting because the methods of deriving the formulas are given in some detail. A study of these formulas will indicate the source of many of those given earlier. His answer follows:

* * *

THE QUESTION has led the writer to investigate the possibilities of developing a general formula for calculating the heat value of coal from the proximate analysis. Using the Bureau of Mines Bulletin 22,* listing coal analysis and B.t.u. values of coals in all the states as a basis, it was found that one formula cannot possibly give a reliable heat value for all coals found in the United States. This was obvious from the fact that those coals in Illinois, for instance, having the identical proximate

*This bulletin is thought to be out of print but similar data is included in Bureau of Mines Bulletin 193 which may be obtained from the Supt. of Documents, Washington, D. C., for 35 ct.

analysis as the coals in Pennsylvania, had entirely different heat values. The heat value in terms of proximate analysis can, however, be expressed in a general formula as follows:

$$H = K_1 C + VK_2$$

where:

H = B.t.u. per lb. of coal
C = percent of fixed carbon
V = percent of volatile
K_1 = B.t.u. per lb. of fixed carbon
K_2 = B.t.u. per lb. of volatile

K_1 and K_2 are constants, H, C, and V are on a moisture and ash free basis. From this general relationship, it is only necessary to determine from the analysis of coals given in the Bureau of Mines Bulletin, the values of K_1 and K_2, and a fairly reliable equation results from which heat value can be determined from the two combustibles, fixed carbon and volatile.

To start with, K_1 or B.t.u. per pound of fixed carbon, was assumed to be 14,600 which, of course, is the heat value or pure carbon. The values of K_2 were determined from various coals in one state for a wide range of volatile content. It was then found that K_2 is not a constant itself, but is a variable depending on the percent volatile in the coal. The data was then plotted on cross section paper, revealing that a straight line relationship exists between the B.t.u. per pound of volatile and the percent of volatile in the coal. This relation can be expressed as follows:

$$\text{B.t.u. per lb. of volatile} = K_1 \pm K_2 V) \quad (2)$$

The general formula for determining the heat value of coal on a moisture and ash free basis is then:

$$H = 145C + V(K_1 \pm K_2 V) \quad (3)$$

Actual values of K_1 and K_2 for coals having the same volatile characteristics can be determined as follows. From the Bureau of Mines Bulletin select a number of analyses of coals in, say, one state, and choosing coals over as wide a range of fixed carbon and volatile content as possible. The analysis on a moisture and ash free basis should be used in all cases. (The Bureau of Mines Bulletin lists coal analyses on an "as fired," "moisture free," and a "moisture and ash free basis"). From the B.t.u. values per lb. of total combustible, subtract 14,600 times the fraction of fixed carbon in the combustible.

The remainder is then the heat in the volatile which when divided by the fraction or percent of volatile results in in a value which may be termed B.t.u. per pound of volatile. Plot these values of B.t.u. per pound volatile against percent of volatile in the coal for the range of coals selected. Then draw a straight line through these points having a slope following the general trend of the points, and with an equal number of points each side of the line.

Extend the curves or straight line so that they intersect the zero percent volatile and zero B.t.u. per pound of volatile lines. From Eq. 2 it follows that where this line intersects the zero percent volatile line, the B.t.u. per pound of volatile will be:

$$K_1 \pm V \times 0 \text{ or } K_1 \quad (4)$$

Where the line intersects the zero B.t.u. per pound of volatile line, Eq. 2 becomes:

$$0 = K_1 \pm K_2 V \quad (5)$$

Having determined K_1 in Eq. 4, K_2 is easily solved. Substitute the actual values of K_1 and K_2 in general Eq. 3 and a specific equation results for the determination on a moisture and ash free basis of the B.t.u. value of coals for the state from which the data was obtained. To obtain the as fired B.t.u. value, of course, multiply this by:

$$[1 - (M + A)/100] \quad (6)$$

where M = percent moisture in coal
A = percent ash in coal.

Following this procedure and based on analyses of coals in Illinois, the following equation was derived for expressing the heat value of coals in terms of fixed carbon and volatile for this state:

$$H = 146C + V(185 - V) \quad (7)$$

$$\text{B.t.u. per lb. as fired} = H\,[1 - (M + A)/100] \quad (8)$$

As before, H, C, and V are on a moisture and ash free basis. This relationship was found to be generally accurate within ± 2 percent for coals in the following states: Illinois, Indiana, Iowa, and Missouri.

Similarly, the following relation was determined from Pennsylvania coal analyses:

$$H = 146C + V(248 - 2.3V) \quad (9)$$

$$\text{B.t.u. per lb. as fired} = H\,[1 - (M + A)/100] \quad (10)$$

This holds true within ± two percent accuracy for Pennsylvania, Ohio, Tennessee, Virginia, and Kentucky.

The heat value of coals in Montana, North Dakota, Wyoming, New Mexico, and several other states could not be expressed in a specific formula because it was found that the character of the volatile matter varied considerably. However, for any particular field within these states, an equation could be developed following the aforementioned procedure which would predict the heat value from the proximate analysis for this particular field. It was also found that if a specific formula is developed for one particular field or district of coal, it was usually more accurate for this particular field than an equation developed to satisfy coals for several districts or states.

In other words, the flexibility of this method permits its application for a large number of coals covering an extended area, or for a limited area covering only one mine with the accuracy tending to increase in an inverse proportion to the number of coal districts or area the developed equation must satisfy.

Brooklyn, N. Y. MARVIN A. SAYLAND

LETTERS AND COMMENTS

The Right Job

YOUR ARTICLE, The Right Job, (p. 72, February issue) has exactly the flavor of the work we are attempting to do. It also opens up the possibility of another article later and I wish you would some time write one on the need in industry of running inventories of aptitudes exactly as industry now runs inventories of materials. There is a real opportunity for engineers to install and operate these aptitude inventories.

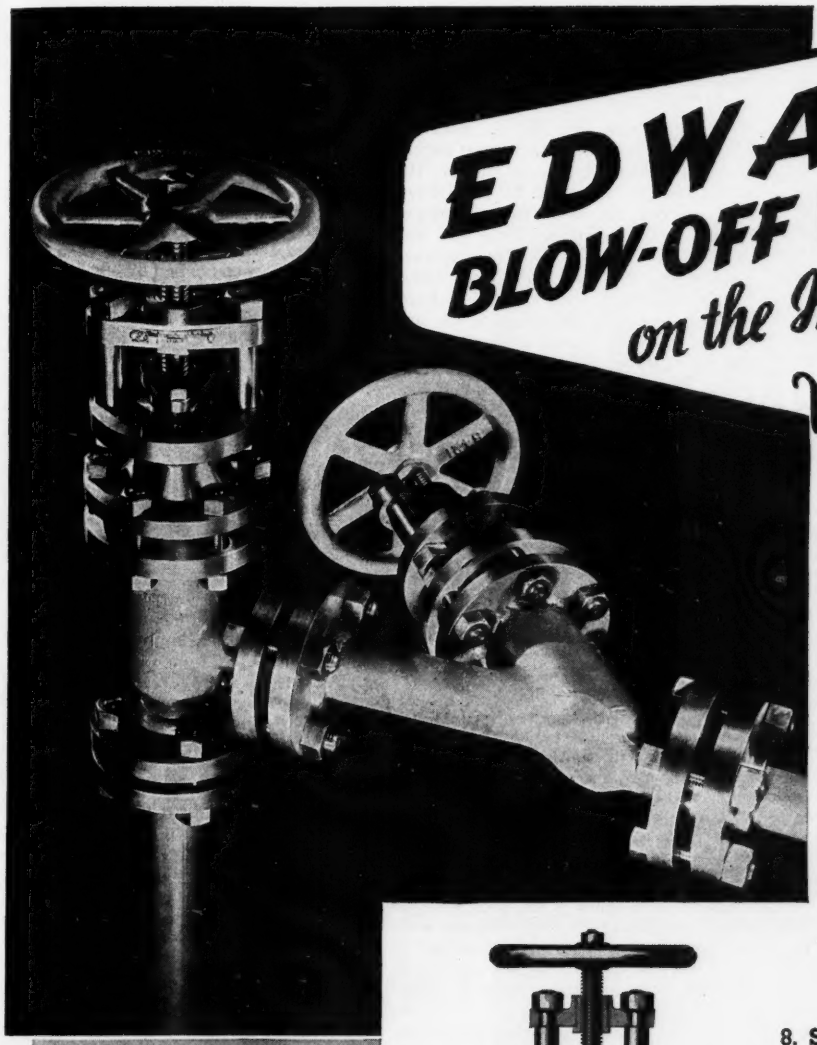
No organization would consider operating today without a carefully controlled inventory of materials, and yet these same organizations hire a man, put him on the payroll, and forget him. When they want some new employee, they go out and hire one. This is exactly the equivalent of going out and buying new materials when there is already some of the wanted material somewhere around the shop.

It seems to me that this is important not only from the standpoint of industry, but that it opens a new field for engineers. Most individuals who have tried to get into aptitude testing in the field of industry have attemptetd to do testing themselves. This resembles a chemical engineer attempting to make his own chemical analyses for it requires a great deal of specialized knowledge; many men have been in aptitude testing 4 or 5 yr. and then have dropped it because they were not well adapted to the work.

I think that the engineer's approach should be not to give these tests himself but to take accurate test results obtained in a qualified testing laboratory and try to use these results constructively in industry. It seems to me, that chemical engineers, for instance, have advanced in this way by using the findings of the analytical chemist and by applying them to the field of industry. This is a notion which I am certain someone will someday push through to completion.

JOHNSON O'CONNOR
Human Engineering Laboratory
381 Beacon St.
Boston, Mass.

Editor's Note: The article referred to covered briefly the work of Johnson O'Connor in the isolation and measurement of natural aptitudes for educational, vocational and industrial guidance. This work, started while he was an electrical engineer for the General Electric Co., has in the ensuing 20 yr. expanded to the point where it occupies the full time of over 50 individuals in three well equipped laboratories which last year tested over 4000 individuals.



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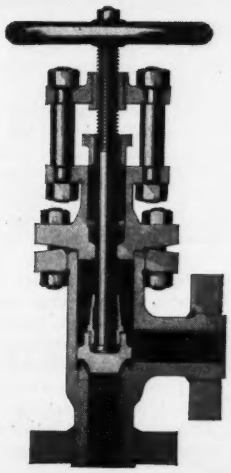
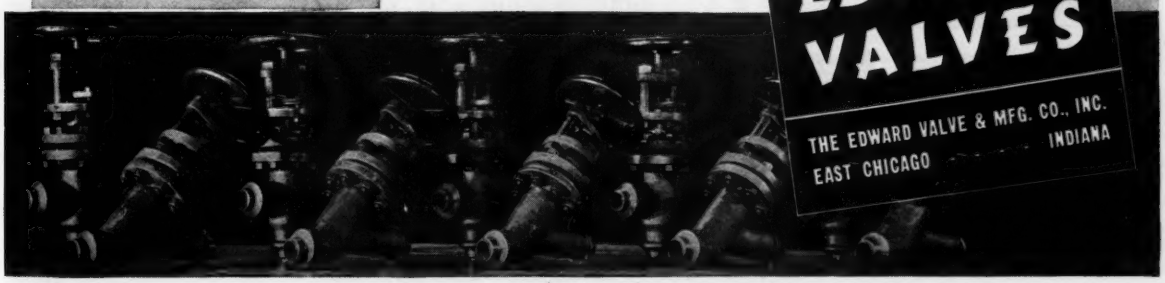
Photos show Edward straightway and angle blow-off valves with flanged and welding ends.





EDWARD VALVES

THE EDWARD VALVE & MFG. CO., INC.
EAST CHICAGO INDIANA

Last year the laboratories were incorporated as a non-profit organization, the Human Engineering Laboratory, Inc., with headquarters and a laboratory at 347 Beacon St., Boston, Mass., and other laboratories at 1800 Prairie Ave., Chicago, Ill., and 509 River St., Hoboken, N. J. Temporary laboratories are from time to time set up in various cities usually under the auspices of schools or local organizations. A fee of $10 is charged for the single appointment tests, which require about 2 hr. and cover 5 aptitudes. Double appointments, recommended for adults, cover all 13 aptitudes now measured, and cost $20. More detailed information and literature can be obtained from the Boston headquarters or from either of the other two laboratories.

Mostly Bouquets for the Ex-Editor

WHILE the ex-editor was out roaming around the East last month, we went through his files and picked out a few of the many comments and compliments which he received while editing P.E. Knowing his natural modesty (and incidentally so the rest of us would not suffer too much in comparison) we skipped over the more personal ones and used those that at least inferred there are others on the editorial staff.

One, however, is too good to pass by for it gives away the secret of his popularity. Eugene George Key, of Chicago, whose avocation at present is getting A.W.K. to give a talk before a local section of the A.I.E.E., wrote: "My only dealings with P.P.E. to date have been with Mr. Kramer, and I have come to think in the past months that no one else could write the friendly letters that he has always written. As a matter of fact . . . his letters are exactly the way that business letters should be written and can be held up as excellent samples for anyone."

There are many references to the contest. George L. Schlaepfer, of Grosse Pointe, Mich., says: "It (Problem 4) was fun to try, but the best part was to see how others suggested such a variety of methods to produce the same result after I thought I had them all."

Some also go farther, for instance W. Freeman Smith of Danville, Ill., also finds a lot of general interest, for "We get no little fun out of sending in these little quips and hunches about your problems; likewise we enjoy reading about the ingenuity of the other like minded persons. The magazine contains a host of other interesting material which we read and find it a fine medium for keeping up with the changes in equipment and techniques in the power world."

While others, like F. J. Ross of Muskegon, Mich., find the contest begets doubt and domestic entanglements. He says, "The problem (No. 5) could have been worked out with more accuracy by using the calculus. However, the calculus with me is like the decimal point with a slide rule,—I'm never quite certain of myself. P.P.E. and I have at least one thing in common, we are both in the dog house with my wife. Me for working such problems for fun and P.P.E. for thinking them up. But bring on some more, I'll handle (?) my wife." Fortunately his copy goes to his business address and we hope that he keeps this month's issue there or we may have a cancellation if not a damage suit or hospital bill.

THE WOMEN—GOD BLESS THEM

You'd be surprised what an interest the women take too. A large part of the new December business was made up of subscription cards sent in by the Missus as a surprise Christmas present for Hubby. If you don't believe they get a kick out of passing an issue which contains his name around the town, try it sometime. We know from experience and here is further proof from Dan Gutleben of Philadelphia, who writes: "Is my face red! Anyhow, thanks for them kind words even if you employed the Editor's license for exaggeration. It is going to make it tough for me when I am seen without wings! However, the wife agrees with you and says she would like to get a spare copy or two. I suppose she wants to send it to the home town to serve as Exhibit A."

In case you missed the article referred to, we show you what Homer L. Rank of Minneapolis telegraphed: "Hearty congratulations on your Scoop-to-end-all Scoops of human interest stories on pp. 534-535 August issue of Chicago's great scandal sheet of the power fraternity, viz. P.P.E. You made a bull's-eye with that one. Gratifying to note quote we will keep some (more about D.G.) for future issues unquote. Hope you will utilize Dan Gutleben's diagram of an ultra-modern power plant and his personally illustrated Instructions for Morning Setting-Up Exercises. To your current caption could have been added the sub-title One Man in a Million!"

The last two are something for you to look forward to—a sense of humor and good physical condition are the only things that enable us to play "the missing link"—no fooling! From down in Augusta, Kan., J. C. De Foe, (who, you will admit after reading—"It's Up to the Management") is a pretty keen fellow) feels that way after reading P.P.E. only 6 mo. He says: "You have an interestig magazine and even though I've had access to it only about 6 mo. I consider it outstanding in its field. . . . To me P.P.E. is the long 'missing link' between practical experience and a technical education."

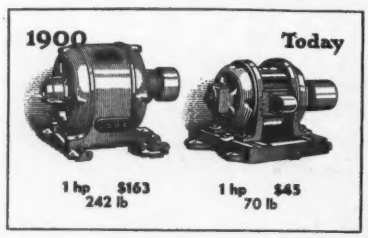
THE SALESMEN

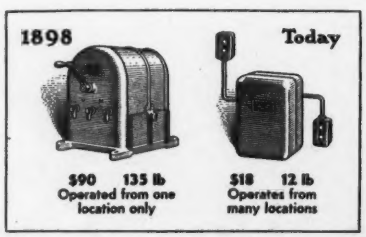
In case you feel these good friends of ours were not sincere, perhaps you'd like to see what Bert Leadley, our subscription man in the Ohio territory, had to say from Cincinnati, "Believe you should know what I'm encountering in the way of salvos and applause for the P.E.&E.—Plant or mechanical engineers like C. Oscar Schmidt—Wm. V. Meale—Karl F. Wiedemann—R. Starr Parker—Geo. R. Williams—also Hugo Vontz . . . practical men—are extremely pleased and say so of their own volition, all unsolicited." And that to a man around after a subscription certainly sounds as though the editorial department gets all the work and the subscription department all the gravy—just a pleasant ride from plant to plant taking orders!

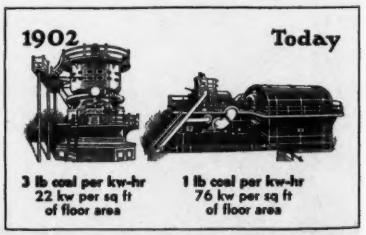
Again some like Charles W. Parks of Baltimore, Md., like the Q.&A. service, for he says, "I would like to take this opportunity to express my deep appreciation for your kind interest to the various questions that I have sent to you. Such service is without a doubt well worth the cost of the subscription a dozen over. As an engineer . . . I assure you this service is priceless."

Harold D. Brown of Chicago, Ill., knows what he likes too—"You have done an excellent job in the P.E. section of P.P.E. I enjoyed H. A. Knapp's article "So, You Want to be an Engineer." He certainly hit the nail on the head when he says that some power plants should be shut down because of the lack of ventilation. That is a question I would like to have an answer to,—Why do engineers tolerate those conditions? Is it necessary or just what is the reason? Perhaps somebody has the answer."

Seems kind of pointless to do anything with Dan Gutleben's Setting-Up exercise if the engineers can't find a bit of good fresh air to set up in.



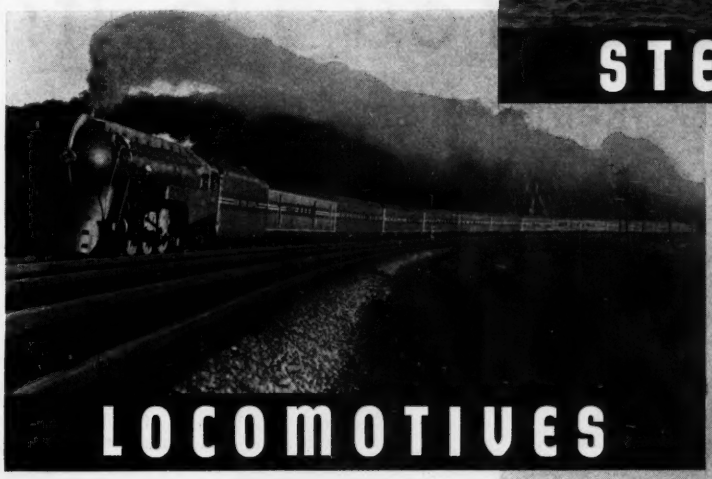




A Story Without Words Picturgraphed by General Electric

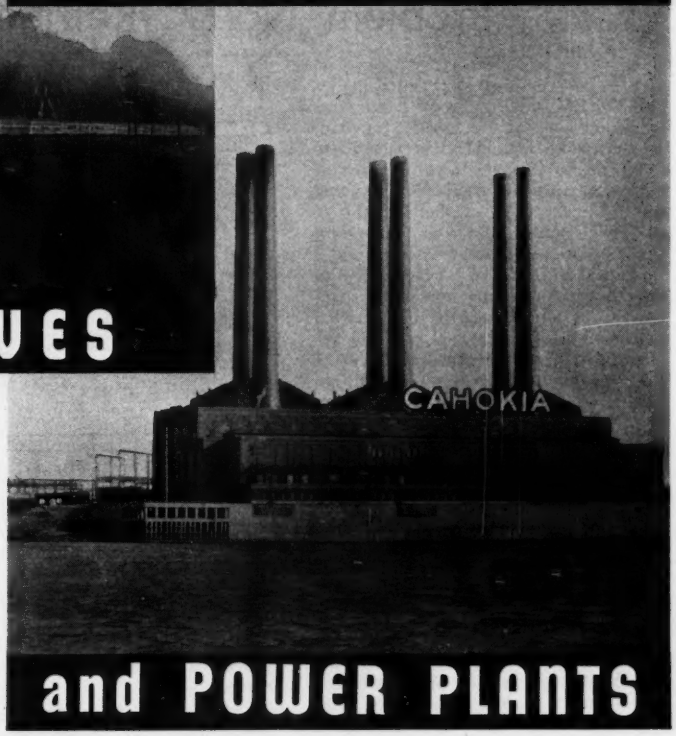
Economical Operation of-

STEAMSHIPS



LOCOMOTIVES

must be continuous and free from trouble!



and POWER PLANTS

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Our Hero is bothered with temperature gyrations in his small refrigeration system involving both a 10 and 40 deg. F. room cooler. When the 40 deg. F. room load goes up and he opens the expansion valve, the 10 deg. F. room drops, and if he again closes the expansion valve the 10 deg. room still drops. When he closes the low temperature expansion valve his compressor heats up. All in all he is in a terrible fix.

How Would You Do It?

Problem No. 7. Refrigeration Control

PROBLEM NO. 7 is probably the most difficult one of the series for both the contestants and judges because there are so many unknown factors. Most of the contestants assumed, what is only inferred in the problem, that our Hero's small plant consisted of a single constant speed motor driven compressor, a single condenser and the two evaporators in parallel with manually operated expansion valves. However, the influence of their own background and plant is apparent for many different arrangements were used and a number of them are shown following the prize awards.

In general, the replies fell into three groups. First, those who felt that a plant of this kind should not be expected to operate without controls unless an engineer were in constant attendance. Second, those who felt that the difficulty could be remedied by minor changes in piping or operating procedure. Third, a large number including several good replies that came in late. We are sorry that for publishing reasons it is necessary to set a closing date on entries, the 25th of the month of issue. Late entries cannot be considered in the prize awards, although when time and space permits, portions are sometimes used following the award winners.

The first award was made on the basis of Mr. Crider's appreciation of the inherent difficulties of *small* multiple systems of this kind with multiple evaporators on variable load which cannot receive constant attention, and his solution to give: 1, control of each evaporator expansion valve; 2, suction pressure control; 3, compressor capacity control; 4, control with the variable load on either evaporator.

FIRST PRIZE AWARD

By Homer H. Crider
Yosemite National Park, Cal.

TROUBLE here seems to be lack of a thermostatically controlled magnetic valve in the suction line of the low temperature coil. It is not recommended that a plant be expected to perform satisfactorily with two coils maintaining

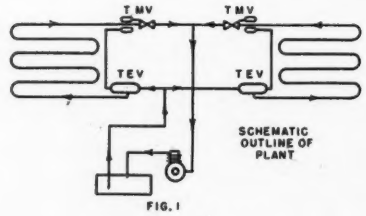

FIG. 1

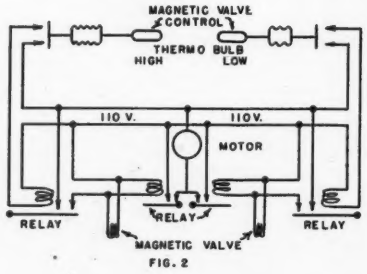

FIG. 2

widely divergent temperatures, unless the proper accessories and controls are included.

Such installations assume the low temperature coil as hardest to satisfy and if control is thermostatic with motor control in low temperature box. Here, however, I get the impression that the high temperature box gets the most use, so the arrangement shows, provides that either can call for refrigeration and get it, likewise either can withdraw temporarily. The drawings, Figs. 1 and 2, are not complicated and will meet conditions without unusual attention.

I regard thermostatic expansion valves as essential and so use a thermostatic controlled magnetic valve on each suction line, with coincident motor control. One might consider using in addition a throttling valve on the high temperature coil to help the low temperature coil get refrigeration sooner, but in this smalll unit it is not necessary. One thing must be said for the magnetic valve: if the motor is running at all, it has sufficient load not to heat up from pinched down load.

DUPLICATE SECOND PRIZE AWARD

By E. H. Carlson
Fresno, Cal.

OUR HERO'S predicament is not uncommon where cold storage rooms with hand-fed direct expansion coils are operated under varying temperatures and loads. Holding a temperature of 10 deg. F. under average conditions usually requires a back pressure of 12 lb. ga. with corresponding evaporating temperature of minus 5 deg. F. Apparently, our Hero is feeding minus 5 deg. F. ammonia into the 40 deg. F. room beyond the limitations of the evaporating surface and the excess liquid ammonia is carried through the suction line into the low temperature room where it evaporates and passes to the compressor in a highly superheated condition; hence the hot machine.

A simple solution would be to reduce the feed to the 10 deg. F. room to prevent excessive temperature drop and connect a ¼ in. liquid ammonia, or add a "freeze-back" line to the compressor suction with a regulating valve to feed sufficient ammonia into the machine to prevent heating. Most compressors are equipped with "freeze-back" lines but are intended only for a temporary expedient as the ammonia thus vaporized performs no useful work.

It is evident that there is insufficient effective evaporating surface in the high temperature room to handle the extra load, and although more expensive than a freeze-back line, it would be better to install sufficient additional piping to take care of the load. It is apparent there is a surplus of evaporating surface in the low temperature room and if our Hero does not have the money to buy new pipe, he can transfer some of the old pipe from the 10 deg. F. room.

Frequently the operation of storage room coils is improved and capacity increased by re-arranging a given amount of piping into shorter coil lengths, and this procedure is well worth the cost of a few more expansion and stop valves. It should be remembered that the accumulation of oil, non condensible gas or

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Fig. 1640 'KING-CLIP'

"THE KING OF CLIP VALVES"

Fig. 1640 is the original clip valve with drain channels and bronze thread bushing in bonnet.

The exterior construction clearly indicates the large drain channels; of ample size to thoroughly drain the bonnet of even fluids which tend to clog.

The bronze thread bushing cast in the bonnet has excellent wearing qualities and provides non-corrodible contact for stem.

Fig. 1640 "King-Clip" also has other important features:-

Bronze stem – perfectly aligned, with repacking seat above threads.

Extra strong stuffing box with hexagon head gland.

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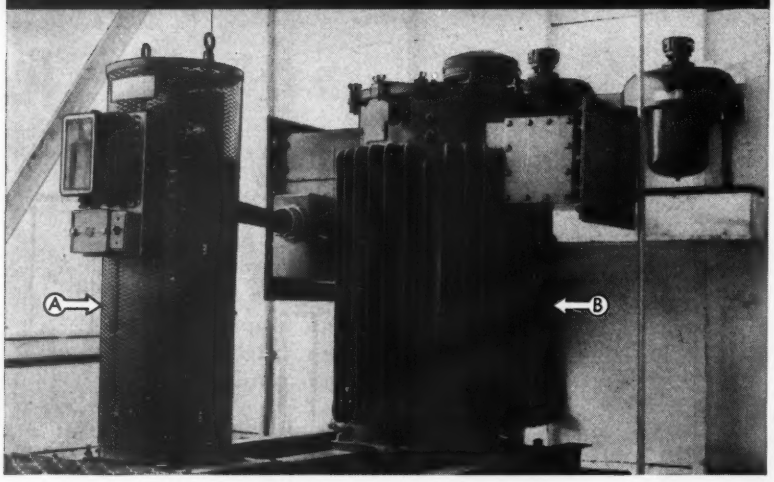

This G-E air-cooled regulator (A) in a modern factory provides precise voltage control for the lamps supplied by Pyranol transformer (B)

You know that voltage delivered at the correct level at your service entrance may fluctuate widely on your plant circuits because of varying power loads and lighting loads. You also know the advantages—in higher efficiency and increased production—of maintaining correct voltage on these circuits.

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They are easily installed. Because they are air cooled, they require no expensive fireproof vaults. They take little space, and can be placed in out-of-the-way locations, even on beams up near the ceiling. Available in ratings from 1.2 to 12 kva, for 120-, 240-, 480-, and 600-volt circuits, and 10 per cent raise and 10 per cent lower regulation.

Find out for yourself how little these regulators cost. Ask your G-E representative for details, or write for Bulletin GEA-3057. Address General Electric, Schenectady, N. Y.

And for Testing—the Voltage You Want When You Want It

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GENERAL ELECTRIC

401-1

other foreign matter in the piping reduces refrigerating capacity and means should be provided for its removal. Frost on the outside of piping is another deterrent but seldom forms in large quantities when rooms are maintained above 32 deg. F.

Assuming that our Hero has a horizontal double acting machine and funds are available for improving plant efficiency, the difficulty can be corrected in the following manner:

1. Install an independent suction line from low temperature room to crank end of machine.

2. Install an independent suction line from high temperature room to head end of machine, which has slightly larger displacement on account of absence of piston rod.

3. Install sufficient piping in storage rooms to maintain temperature differential between air and ammonia of 15 deg. F. As present differential is 40 deg. F., room is 45 deg. F., the amount of piping in this room would probably have to be tripled. This will raise the back pressure on high temperature room to 39 lb. ga. with corresponding evaporating temperature of 25 deg. F. and just about double the weight of ammonia handled and work performed by the head end of the compressor. When the additional machine capacity is not required and abnormally low temperatures are encountered, shut down the plant and save power. Roughly, this will reduce operating hours about 25 per cent and the power saving would effect a good return on the investment.

DUPLICATE SECOND PRIZE AWARD

By Bernard T. Hensgen
Plant Engineer
Swift & Co.
National Stock Yards, Ill.

OUR HERO'S two coolers are evidently on the same condenser and suction pressure and any manner in which one is affected will similarly affect the other. Thus when the additional load is introduced into the high temperature cooler and the expansion valves are opened up there is a reduction in condensed pressure and an increase in suction pressure. In effect, he has temporarily increased the capacity of his system inasmuch as the compressor handles more gas per minute while less gas is actually required per ton of refrigeration produced. Moreover, the condenser will have less heat to remove from the ammonia and thus will be able to further sub-cool the liquid. This increased refrigerating effect is absorbed in the high cooler by the added load but the low temperature cooler responded to this condition with lower temperature.

When the expansion valve on the 10 deg. F. cooler was closed the compressor got hot because the condenser pressure rose abnormally high. Evidently, an appreciable percentage of the load was removed when this valve was closed. Thus, we would believe that the ratio of added load to normal load is rather small.

Closing the expansion valves on the 40 deg. F. room caused the condition to be further aggravated by which we believe is meant that the low temperature cooler again went below its normal 10

deg. F. temperature. This was no doubt caused by the lower expansion temperature caused by reduced suction pressure. This strengthens the opinion that the high temperature cooler represents only a small portion of the total load.

Therefore, we must stake our chances of helping our Hero out of his trouble by advising him to merely pinch back on the expansion valve of the low temperature cooler before opening the expansion valve of the high cooler. It may be necessary for him to open the high valve gradually and it would help somewhat if he would let his high cooler temperature drop a few degrees before introducing the additional load.

From our diagnosis of the cause and picture of the load situation, we believe our Hero should be able to keep his system in balance by proper manual regulation of the present expansion valves.

THIRD PRIZE AWARD

By Walter H. Harvey
Merchants Ice & Cold Storage
Cincinnati, O.

TROUBLE in our Hero's temperamental refrigeration system apparently is in the suction line hook-up but could be one of these three:

First. The suction lines from these two cooling rooms are evidently hooked up in a manner that permits raw liquor from the high temperature cooler to back up in the coils of the low temperature cooler. The problem states that the system has always operated satisfactorily but lately a slight change in load on the high temperature cooler has brought about the difficulties. During certain hours of the day when it is necessary to increase the load on the high temperature cooler the expansion valve for the cooler is opened up a little more.

Coils in this high temperature cooler are most probably small size or else very short because not very much heat absorption surface is necessary in a room of this temperature (40 deg. F.). (The problem also states that this system is a small one.) When the expansion valve for this cooler is opened up to take care of the increase in load the coils are probably overloaded and can't evaporate the liquor fast enough. The raw liquor then goes into the suction and backs up into the low temperature coils.

Second. If raw liquor leaving the low temperature cooler is not the case, the trouble may be due to the condensation of the gases in the suction line from both coolers and this condition would also permit the condensate to back up into the low temperature cooler.

Third. If the compressor is speeded up to take care of the extra load and there are no suction pressure gages to go by there is a possibility that the suction pressure may be pulled down lower than previously. As for the compressor running hot when the expansion to the low temperature cooler is shut off this condition is brought about by the high superheat of the gas from the high temperature cooler. This condition can be remedied by running a small liquor line into the suction header close to the compressor and expanding a little liquor into the suction gas.

This of course will most likely cut down the capacity of the compressor a slight amount. I say "most likely cut down the capacity a slight amount," because there is a slim possibility of increasing the capacity of the compressor. The amount that the expansion valve in the suction line must be opened to effect this increase in capacity can only be found by the hit and miss method and the use of gages.

Our Hero's trouble is not a common fault inherent in such a system. As said before it most probably is in the suction line hook-up. If this is the case a change in the suction lines from the two coolers to the compressor is the simplest remedy. If this is done correctly the load on either cooler may be varied without affecting the temperature of the other cooler. The problem states that there is only one compressor, so evidently there is only one suction pressure. If the expansion valve on the high temperature cooler is opened up more it will raise the suction pressure and consequently the temperature of the low temperature cooler will raise slightly if this condition exists for any length of time.

Of course if the compressor can be speeded up to take care of this increase in load the low temperature cooler will not be affected. Or maybe our Hero has automatic valves installed in the suction lines and expansion lines for each room and these in turn control the speed or intermittent operation of the compressor to take care of the increase in load.

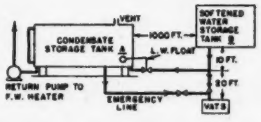
GENERAL COMMENT

IN ADDITION to troubles that might be considered as normal or inherent with the system a number of abnormal conditions were mentioned as possible causes of erratic conditions. Carl Egerter of New York points out logically "that when you open an expansion valve by hand you are apt to open it too wide." What the experts term "process lag" is something that can be estimated by experience for there is a natural tendency to hurry matters along by over correction.

Edward W. Longner of Chicago feels that it is "caused by losing the liquid seal in the receiver . . . (when) . . . the expansion valve is opened on the 40 deg. room to maintain the temperature. . . . This same condition could exist if a restriction occurred, trapping or slowing down liquid returns to the receiver." We have in the files now for early publication an article dealing with an instance of this kind.

Improper attention to detail is blamed by Harold D. Brown of Chicago, who says: "It is evident that the system contains non-condensable gases. . . . When the expansion valve to the coils in the warmer room is opened more the coils serve as a by-pass for the non-condensable gases and allow the more nearly pure ammonia to pass through the low temperature coils where it will absorb more heat than when mixed with the non-condensable gases. In an ammonia system the system must be purged of foul gases and the oil accumulator drained at regular intervals or the system will not work satisfactorily."

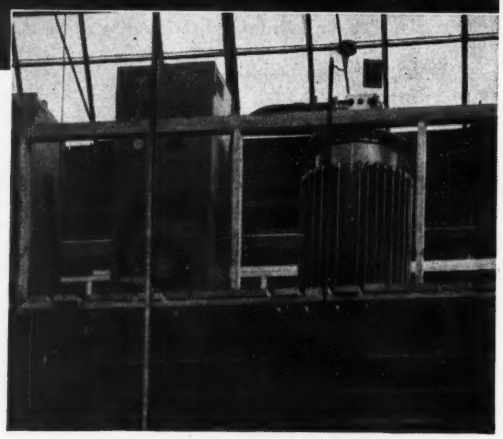
Problem No. 9. Tank Level Indicators



This month our Hero is puzzled about a problem in the boiler room. All condensate returns go to a tank above the feedwater heater and overflow to a condensate storage, Tank A, in the basement. Makeup when needed is added automatically through the low level float valve from softened water storage Tank B about 1000 ft. away. Due to the low head and small pipe size this flow is small, in fact there is a tendency for the flow to reverse at times due to velocity in the filling line from Tank B to vats in the plant. During the night Tank A fills up but Tank B is often low so an emergency line from Tank B to the vats was added to avoid process delays due to low water. However, the men use the hot water from Tank A in preference to cold water from B, as a result Tank A is often drained and raw water has to be used in the boilers. This upsets the boiler treatment. The emergency line cannot be shut off but our Hero wants to rig up a signal system on the firing floor so the boiler room foreman can tell whether the condensate is being used needlessly. This should consist of: 1, an indicator to show the level in Tank A; 2, the same for Tank B; 3, an alarm to show when there is flow through the emergency line. Oscar, out in the boiler room, thinks it would be well to arrange the alarm so it would work only when there was flow through the emergency line while there was still water in Tank B. If there is no water in B he cannot complain about the men filling the vats from Tank A. (Contest entries —not to exceed 1000 words—must be in by March 25. Complete contest rules on page 461, July, 1939, issue.)

Here's a Profit Tip--

Put G-E PYRANOL Transformers at Load Centers



-- for Savings Like These

1. "We saved $500 on installed cost by using a Pyranol transformer to supply a lighting load," says R. H. Lewis, electrical superintendent of the Motor Wheel Corporation, Lansing, Michigan. This saving was possible because a fire-proof enclosing vault—which would have been required with an oil-filled transformer—was unnecessary, and because floor space was saved by mounting the Pyranol transformer on an overhead platform. By placing the transformer right at the load center, the cost of running a heavy three-wire secondary for 500 feet was also avoided.

2. The Byron Jackson Company, Los Angeles, installed a bank of three 200-kva Pyranol transformers in space that could not be used for production. The non-inflammable feature of Pyranol enabled this company to save the cost of building in the production area of the plant, an underground vault, which would have been required with oil-filled transformers.

3. Putting a Pyranol transformer at the load center cut feeder costs 50 per cent on a lighting circuit in the new recreation building of an Alabama cotton mill.

Find out for yourself how you can save on power- or lighting-circuit installations by installing G-E Pyranol transformers indoors at load centers. After installation you will get daily dividends in the form of reduced copper losses, better voltage regulation. Ask your G-E representative for complete information, or write today for Bulletin GEA-2736. Address General Electric, Schenectady, N.Y.

GENERAL ELECTRIC

402-4

An insufficient refrigerant charge would cause the trouble, says J. L. Grant, of Chicago, but if this is not the case, he feels that the erratic operation is caused by liquid in the suction line backing up into the evaporator, for "I have had a similar experience with a brine tank when the brine temperature would go down after shutting-off after the load on another tank increased."

Julius Brodsky, of Rochester, N. Y., is skeptical of engineers who talk of balanced conditions in the plant when they "lack thermometers and data to confirm their opinions." He analyzes the possible conditions thoroughly and on the basis of a 100 per cent load increase on the 40 deg. evaporator, calculates the suction pressure might increase 10 lb. and the head pressure 20 lb., the increased pressure across the 10 deg. expansion valve, acting as a fixed orifice, would cause a greater flow and lower room temperature. He concludes:

"Our Hero might find it advantageous to increase the amount of condenser water at increased loads so that the head pressure will not rise too rapidly with an increase in load. The general impression to be gained from our Hero's problem is that the evaporators in both rooms have sufficient surface so that the plant could be operated at a higher back pressure and that the capacity of the compressor is in excess of the present requirements and is now operated with too low a back pressure. As all small compressors are generally belt driven, it would not be a very expensive proposition to substitute a smaller motor pulley for one now in use, thus decreasing the compressor speed and raising the back pressure, this would result in the use of more effective evaporating surface and less superheating surface with a decrease in superheat of the suction vapor, the compressor would run cooler, power consumption would be lower and the boss should be happy because he will be getting better service at a lower cost. If the higher back pressure does not eliminate former troubles the evaporating coils in the high temperature room should be checked and their area cut down to that which is actually needed."

Harold E. Gethoefer, Down's Brewery, Buffalo, N. Y., feels that the trouble is improper attention to pressures and says in part, "You are carrying too low a suction pressure and too low a condenser temperature . . . but . . . hold 40 deg. on one box and 10 deg. on the other. Then you open the expansion valve on the 40 lb. box . . . the liquor that laid practically dead in the 10 deg. box evaporates . . . and down goes your temperature. The thing to do is to reduce the amount of water in the condenser until 150 lb. head pressure is obtained. That will bring the suction pressure up . . . (find) by trial the best suction pressure using as little water as possible . . . when he has to give the 40 deg. box a touch on the expansion valve that box will come and the 10 deg. box will stay where it belongs because the gas is being handled properly in both rooms.

"This is figured on the basis that our Hero is running a plant without a vari-

able speed motor. All he has to do is keep the suction pressure up to at least 10 lb. (15 lb. is more suitable for his work) and save about ½ the water he's now using and ¼ the electric power. If your machine is doing all it can you can do a little more by lowering the condenser temperature as low as possible, but that doesn't hold true when you are running at a very low suction pressure, then it works the other way. What's true on one machine is true on all if well built and on a tight system."

J. W. Poyner, shift engineer of the Beatrice Creamery, Topeka, Kan., assumes a variable speed two cylinder compressor and recommends: "Plants arranged for two suction pressures use one machine cylinder for high temperature rooms and the other cylinder for low temperature rooms with a tie valve connecting the two systems. When the heavy load comes on his 40 deg. cooler our Hero speeds up his machine and opens the expansion valve on the 40 deg. cooler, the extra machine speed drops the suction pressure on the 10 deg. cooler which also drops the temperature. . . . By opening the tie valve the required amount I would carry the same suction pressure on 10 deg. cooler while operating at high speed as is carried at normal load and speed."

William T. Conley of Baltimore, Md., considers the problem one of more adequate control and offers two arrangements, one with a dual suction compressor, the other with a booster and considers the question of efficient operation. His reply follows:

"Place a thermostatic expansion valve on each coil with close adjustment for required temperature as shown by Fig. 3. Put either a pressure regulating valve or a snap action valve in 40 deg. suction line. This valve will control the temperature in this coil. Operate the compressor from the low pressure control from the 10 deg. coil. As long as the low side calls for operation the compressor will run. An improvement would be to use a single suction compressor with this valve arrangement and run both suctions to an accumulator and run on low pressure control. This way either coil will operate the compressor.

"Since both units are served by the same condenser they may not be very efficient at a great differential in one and small differential at the other. I think the method shown by Fig. 4 is best. With the same piping arrangement I would discharge my small coil into the accumulator and also the suction from the large coil. I would operate each compressor by low pressure control and if the smaller unit starts first it will operate the large unit. The low head pressure here saves in driving power and higher suction pressure increases efficiency of larger compressor. This still leaves sufficient head pressure for refrigerant feed. The all around best solution would be independent units with complete condenser and equipment. I have used the method shown by Fig. 4 with hand controlled steam drive and cut down the fuel consumption."

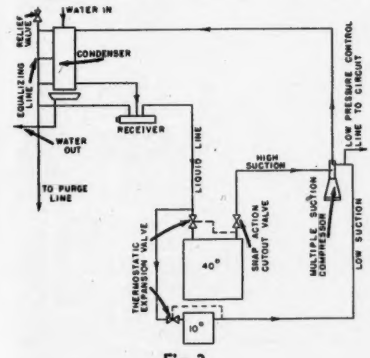


Fig. 3

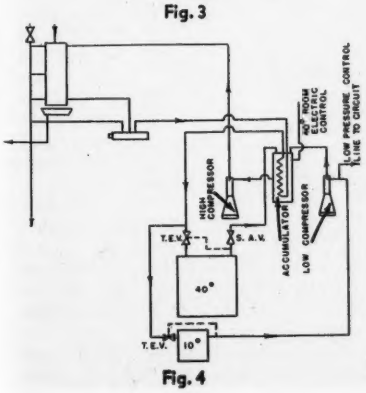
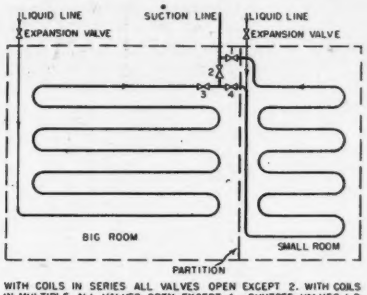


Fig. 4



WITH COILS IN SERIES ALL VALVES OPEN EXCEPT 2. WITH COILS IN MULTIPLE ALL VALVES OPEN EXCEPT 4. SHUTOFF VALVES 1 & 3 USED TO CUT OUT COILS FOR REPAIRS, ALWAYS OPEN WHEN ROOMS ARE OPERATED.

Fig. 5

While all the others gave consideration only to coils in parallel or multiple, A. G. Solomon of Bradbury Heights, Md., gave consideration to a series arrangement and outlined a very flexible hand control. For this reason a portion of his reply is reproduced below:

"Coils of the two rooms are connected in series, the vapor from the coils of the large room going through the coils of the small room before passing into the suction line. On such an installation there are, or should be, valves provided so that the coils of each room can be operated separately when necessary. The drawing (Fig. 5) shows the usual hook-up. During regular operation with the load for which the plant was designed, the ammonia travels through the coils of the big room, through valves 3 and 4 and through the coils of the small room. Valve 2 remains closed while coils are operated in series. By closing valve 4 and opening valve 2 the coils of each room are operated separately.

"Valve 2 is often adjusted by opening a small amount to allow a greater amount of ammonia to be evaporated in the coils of the large room without all of it passing through the coils of the small room. During the time when the large room is handling the extra load it may be necessary to separate the coils and handle the rooms separately. Next method would be to operate with expansion valve to small room closed and regulate the flow of ammonia by adjusting valves 2 and 3 so as to allow just enough vapor to pass through the coils of the small room to maintain the desired temperature. The rest of the ammonia evaporated in the coils of the big room will pass direct to the suction line through valve 2 which will be nearly if not wide open.

"I advise our Hero to operate the rooms separately during the time of the added load. But if he wants to do so he can allow the vapor from the coils of the large room to become superheated 5 deg. above the saturated temperature and allow the greater part to go direct to the suction line. Then the expansion valve of the small room must be opened enough to remove the superheat from that vapor which enters the coils from the big room. This is necessary so as to have a temperature difference and allow heat transfer."

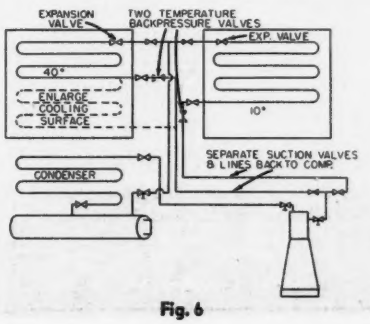


Fig. 6

One of the replies that came in late was from B. W. Hay of Detroit who discussed ammonia carryover from the 40 deg. to the 10 deg. evaporator and compressor heating due to high superheat. Changes which he suggests to remedy the difficulties are:

"1. Installation of two temperature valves on the suction lines just outside of coolers. This is a diaphram or bellows, adjustable spring load valve and can be varied as to suction pressure to header and thus balance the refrigeration load by the adjustment of said valves.

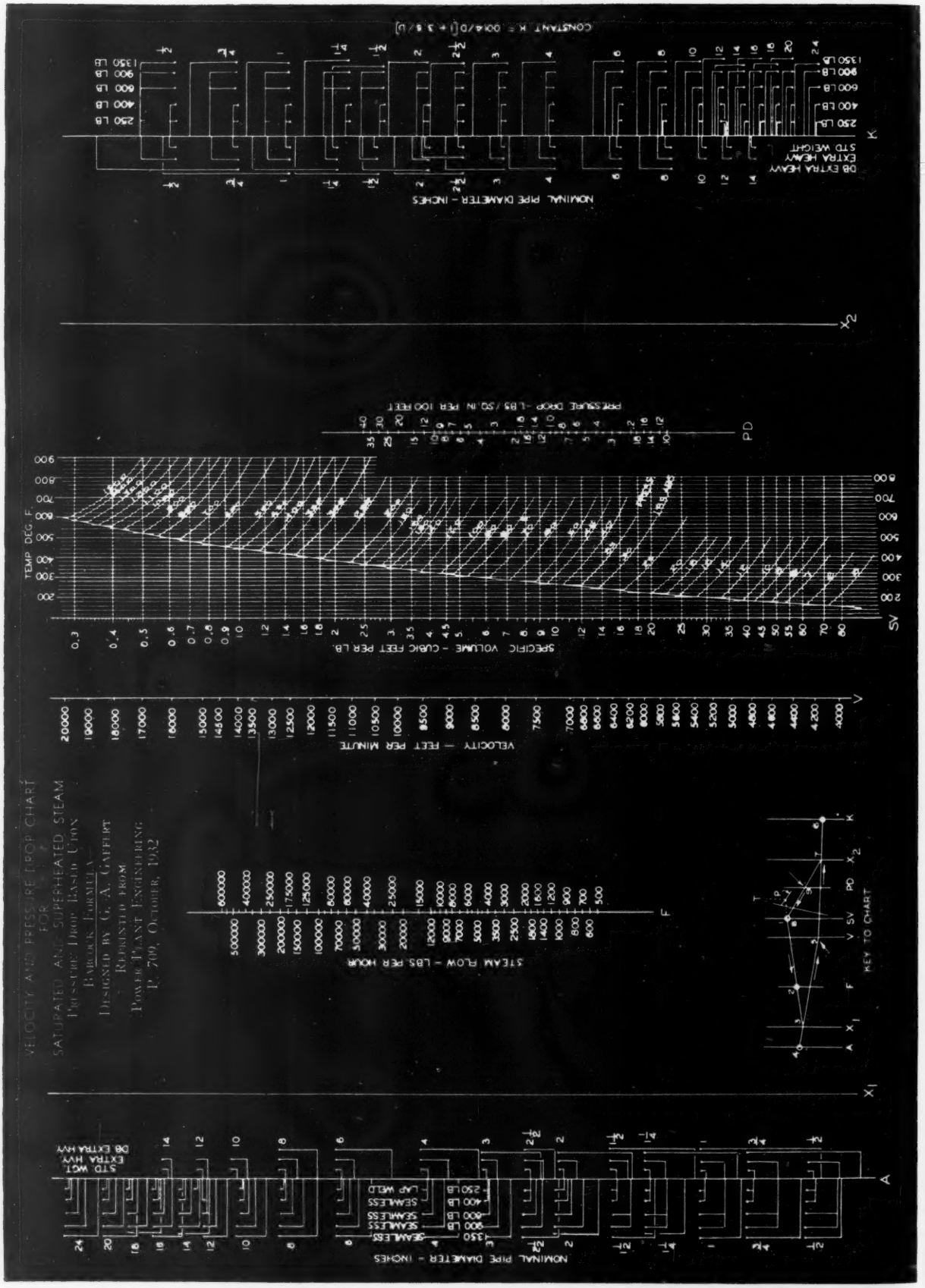
"2. Run the two cooler suction lines down near the compressor before connecting them together and here watch frost back and load conditions.

"3. Increase coil cooling surface in 40 deg. F. cooler.

"4. Installation of suction line checks.

"5. Gradually close 10 deg. cooler suction line valve. This may, however, further aggravate the erratic operation.

"The simplest and probably the least expensive way would be No. 3, above although any of these may correct the trouble. All correction methods mentioned are incorporated in Fig. 6."


VELOCITY AND PRESSURE DROP CHART
FOR
SATURATED AND SUPERHEATED STEAM
Pressure Drop Based Upon
Darcy's Formula
Designed by G. A. Gaffert
Reprinted from
Power Plant Engineering
P. 709, October, 1932
CONSTANT K = .0014/D(1 + 3.6/D)
NOMINAL PIPE DIAMETER - INCHES
DB EXTRA HEAVY
EXTRA HEAVY
STD WEIGHT
250 LB
400 LB
600 LB
900 LB
1350 LB
PRESSURE DROP - LBS./SQ.IN. PER 100 FEET
PD
TEMP DEG F.
SPECIFIC VOLUME - CUBIC FEET PER LB.
SV
VELOCITY — FEET PER MINUTE
V
STEAM FLOW - LBS. PER HOUR
F
KEY TO CHART
STD WGT.
EXTRA HVY.
DB EXTRA HVY
SEAMLESS
LAP WELD
A
X1
X2
K

Over-Motoring the Load

Load requirements of machines, the speed of the driving element, the character of the load curve need careful consideration when selecting a motor to drive the machine, for these conditions affect the size of motor, the speed, the average power factor and year-around economy.

By C. C. HERMANN

OVER-MOTORING the load is a common fault in many individual electric drive plants. It is perhaps the most common of all faults in induction motor applications. The apparent reason for this is inadequate information relative to the power required by the machine in question and inadequate information regarding the characteristics of motors used. Particularly, I believe, it is due to a lack of information on the importance of power-factor control, how low power-factor affects the productive capacity of machine tools and increases the investment in copper necessary to handle the power load. The following paragraphs will show the importance of investigating these factors.

In my many observations of motor applications, I find a definite leaning toward the 900 and 1200 r.p.m. motors. Just why this is so is difficult to understand as 1800 r.p.m. motors have a lower list price, have better characteristics and can be purchased in the gear-motor design to give almost any terminal speed desired.

A Case Study

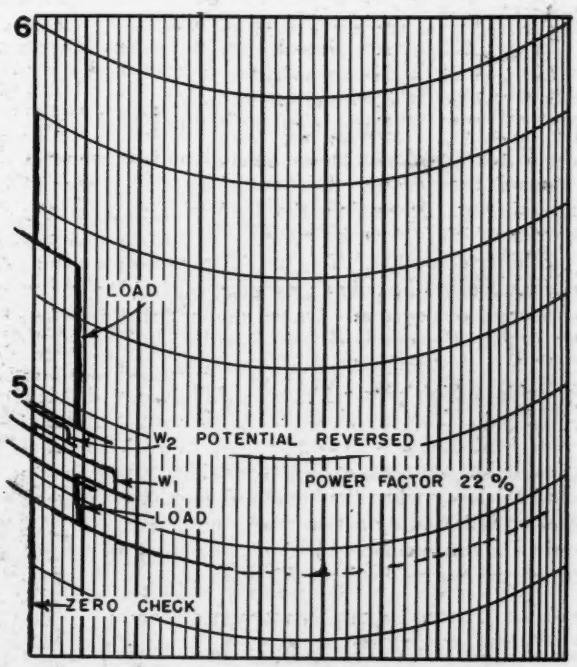
From many tests of individual drives I have selected a few at random which are given in the following table. Some of these show power-factor which is slightly out of line with what one would expect but they indicate the trend in motor application as we find it today. Note also that speeds are kept relatively low.

HP.	R.P.M.	Machine Driven	HP. Max.	HP. Min.	Power Factor
7½	1200	Broach	9.5		75
7½	900	Radial drill	3.35		50
7½	1200	Mill	2.41		46
10	1200	Lathe	3.35		45
15	1200	Boring Mach.	6.86		45
5	1200	West. Radical	2.48	.77	44
20	1200	Mult. Drill	6.03	2.01	55
20	1200	Mil. Mill	17.4	2.85	74
7.5	1200	Rigid Mill	5.36	.335	55
2	1200	Grinder	.035	.7	38
2	900	Assem. Conv.	.6		22

Numerous other examples could be given. These, however, will suffice to indicate that much can be done in power conservation by checking up on the loading and speed application of electric motors. To further emphasize the necessity of checking motor loads the wattmeter chart for the last example given in the table is shown herewith. The job consisted of an assembly conveyor drive using a set of reduction gears and motored with a 2 hp. 440 v., 3 ph., 60 cycle, 900 r.p.m. synchronous speed induction motor. The conveyor was fully loaded with product and operated continuously. The chart speed was 12 in. per min. and the full scale ratio is 5 kw. or 6.7 hp.

The instrument was checked for accuracy before placing on the job and then checked for zero as indicated. The starting current is difficult to obtain due to the swing of the pen; however, since it is merely an instantaneous consumption it is relatively unimportant. The load showed 0.09 on the chart which multiplied by the scale gives 0.45 kw. or 0.6 hp. To obtain the power factor the potentials were reversed giving for $W_1 = 0.16 \times 5$ or .08 kw. and for $W_2 = 0.07 \times 5$ or 0.35 kw. Tan $O = \sqrt{3} \times \left(\frac{0.8 - (-.35)}{0.8 + (-.35)}\right) = 4.45$; the corresponding cosine of the angle is 0.22, therefore the power factor is 22 per cent. This job should be motored with a ¾ hp. gear motor 1800 r.p.m. instead of a 2 hp. 900 r.p.m. in which case the power factor would be 85 per cent. It is generally considered that electric motor cost to the manufacturer when taking into consideration all factors such as maintenance, interest charges, depreciation and power costs is $30.00 per hp. per year. On this basis alone the saving due to changing the motor for one more nearly conforming with the requirement will be $37.50. A saving well worth while. The cost of changing the motor is primarily labor and would not exceed $5.00.

Checking the eleven examples given above for power factor, we note that the average power factor



Wattmeter chart from a 2-hp. motor carrying load suited to ¾-hp. motor

is 49 per cent. The total kw. maximum loading is 42.8 and the kv-a. is 87.4. By the use of 1800 r.p.m. motors the average power factor would have been increased 11 per cent or to 60 per cent. The kv-a. would then be 71.3 as compared with 87.4. The saving would be 16.1 kv-a. of generating capacity, a quantity well worth saving.

Again if the motors were specified to more nearly conform to their loading and the synchronous speed maintained at 1800 r.p.m., the power factor would be about 85 per cent for the group showing a saving of 37 kv-a. in generating capacity. If such savings can be shown in connection with a small group such as shown, what would the possibilities be with an entire plant having thousands of individual drives?

Power Factor and Motor Size

The control of power factor by properly selecting the motor size and speed to suit the load requirement is not generally appreciated. Power factor clauses providing for penalty when the power factor goes below a given figure and a reduction in the demand charge when it goes above a given figure has become common in power contracts and this has caused some to take cognizance of the power factor conditions. The power transmission system, however, suffers a relapse in capacity when the power factor falls, motors lose capacity due to reduction in the line voltage and machines lose capacity due to slowing down when placed under loads in cases where the guess as to motor size is somewhat closer than in the examples given above. The following table shows some machines with individual motor drives having satisfactory power factor.

	Syn.		HP.		Power
HP.	R.P.M.	Machine driven	Max.	Min.	Factor
7.5	900	Gisholt Sim.	6.7	1.34	76%
10	1200	Gisholt Sim.	6.14	2.34	74%
7.5	900	Am. Broach	6	2.3	72%
7.5	1800	Multiple drill.	5.88	.737	85%
5	1200	Kingsmith mill	4.28	.8	73%
3	1200	Natco mult.	3.49	1.47	75%

When we select a motor for a given load we must control the torque. Torque is controlled by increasing or decreasing the load placed upon the motor which is done by moving the motor from one machine to another. This may appear odd to some; it is, however, the only way we can control the power factor of our system. The motor manufacturer has built into the motor certain definite characteristics which we cannot change. The motor is built to provide a high power factor at full load with high efficiency. The power factor at three-quarter load, half load and at starting is kept as high as practicable but we must expect to sacrifice power factor and efficiency when the load on the motor is reduced below full load or a low speed motor is used. All other factors connected with motor operation depend upon the torque load placed upon it.

Power Factor Varies with Torque

At zero torque the only current flowing to the stator of the motor is the exciting current, there being practically no rotor current or no load component of stator current. The zero load power factor of the motor depends upon the relation existing between the power component and the magnetizing component of the exciting current. Because of the air gap between the stator and the rotor of the motor, the magnetizing component of the exciting current is large and the power component small therefore the power factor at zero load is low. Now when the motor is placed under normal load the magnetizing component of the exciting current remains about the same but there is a heavy increase in the load component so that the power factor of the motor will very nearly equal the power factor rating as given by the motor manufacturer.

We may wonder why the power factor of the motor does not continue to increase as we overload the motor. This is because of increase in slip and rotor frequency changing the ratio between the reactance and resistance.

Likewise the efficiency of the motor is dependent upon the load placed upon it. At zero load the in-put is equal to the total losses and the efficiency is zero. As we increase the load on the motor increased current is used and the I^2R losses increase in proportion to the square of the current. The efficiency will rise with the load until the total variable losses equal the total constant losses. If we increase the external load above this point the efficiency falls due to the very rapid increase in the I^2R losses. It is therefore obvious that the electric motor should be loaded at or near its rated load and as recommended by manufacturers never on constant duty in excess of 115 per cent rated load. On the surface of things, which is as the casual observer sees his electric transmission system and electric power consuming equipment, things look calm and easy when motors are overly large for the duty assigned to them and only give individual trouble when overloaded. Somewhere along the line, however, it is costing dollars and cents to maintain motors larger for the job or low in synchronous speed when 1800 r.p.m. could be used.

New Synchronous Motor Control

A new synchronous motor control featuring the Slip-cycle impedance SCI relay developed by General Electric permits the device that allows accurate control of synchronizing speed, so that the field cannot be applied until the motor has reached a speed at which it can synchronize its load. This speed is easily set on a trial start by an adjusting screw on the front of the relay. Undesirable current and torque fluctuations are avoided, because field can in no case be applied unless the load can be synchronized.

This control waits until motor reaches the correct speed, and then selects an instant of favorable angular relation of stator and rotor poles to apply field in order to take advantage of the inherent synchronizing ability of the motor. The SCI relay also prevents pulsations in case of motor pull-out by promptly disconnecting the power (or field if automatic resynchronization is desired). Protection of the squirrel-cage winding during starting and the stator winding during running is provided by separate relays.

Refrigerant Losses

Ammonia losses should not exceed about 5 per cent of the total supply annually in a well operated modern plant but Freon is harder to hold and losses will run around 15 per cent. Records show from 0.0516 to 0.1300 lb. of ammonia per ton of ice made.

By
Terry Mitchell
Frick Co.,
Waynesboro, Pa.

EVERY ENGINEER operating a standard refrigerating plant has at some time asked himself the question, "What part of the charge of ammonia should I have to replace, each year, if reasonable care is used to prevent leaks?" The answer is, from five to ten per cent. To a theorist these figures seem unnecessarily high: to a practical man they seem low!

Recent improvements in piping, pressure vessels, machinery, and auxiliaries have indeed aided engineers in cutting almost in half the losses of ammonia formerly expected. Ten or fifteen years ago, when ammonia sold for upwards of 35 ct. per lb., it was not unusual in ice plants to figure the cost of the refrigerant as 5 ct. for every ton of ice produced. Those were the days of atmospheric and double-pipe condensers, pipe coils between every row of ice cans, screwed return bends, hand purging and engine rooms with a mixture of steam, oil, and ammonia always in the air.

Even today, an experienced eye may note places at which oil is gathering on a discharge line, especially near the ceiling, where an unsuspected leak is constantly robbing the system. Ammonia also escapes when oil is drained from the separator, as the fumes rising from this oil will prove. A modern purger, if large enough and if skillfully used, will prevent nearly all of the loss while ridding the system of air and foul gases. The newest purgers condense under full receiver pressure the ammonia coming over with the gases, and so further reduce the relative amount of ammonia vapor blown out with the mixture.

Shaft seals on compressors, first made double length, then kept flooded with oil, and now employing a sliding ring instead of packing, account for less leakage than ever before. Where soft packing is used, there will be less heating and, in the end, less oil and ammonia escaping, if the new packing is fitted snugly against the inside of the box, instead of against the shaft, while being installed.

It is not so difficult to prevent leakage around the smooth shaft, turning in a film of oil, as to make a gas-tight seal between the packing and the comparatively rough inner surface of the box. In some cases the box is not even at a uniform distance from the shaft, and if the packing is merely fitted around the shaft, excessive pressure is required to seal it against the wall of the box. A well packed stuffing box will hold ammonia when the gland nuts are only *finger* tight. The recently perfected ring-type seals give the greatest convenience and freedom from ammonia smells: any danger from heating is avoided by cooling the seal with a small water circuit.

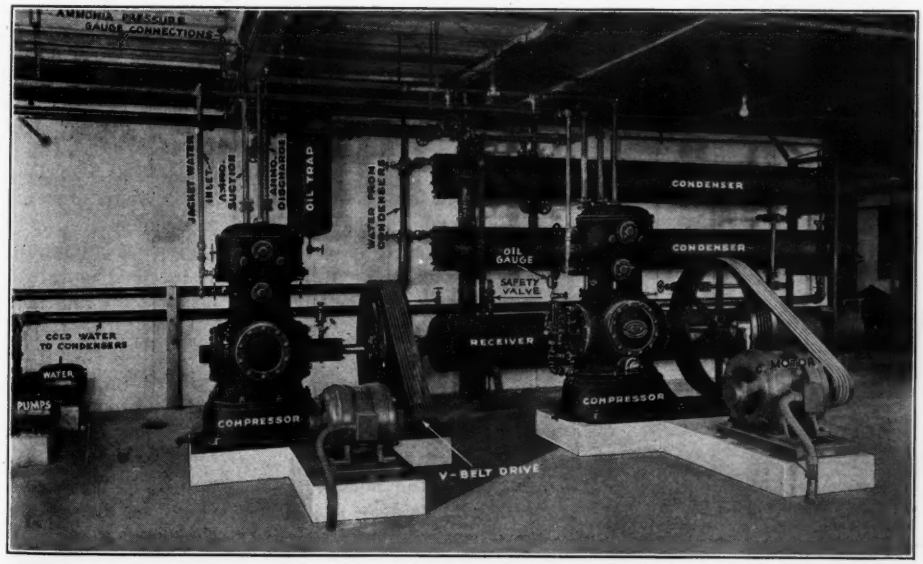


Fig. 1. Photograph showing principal parts of the high-pressure side of a typical refrigerating plant. Points to be watched for leaks include the shaft stuffing boxes, water jackets, flanges in the ammonia piping, drain from oil trap, the four-tube heads of the condensers, and the safety relief valve

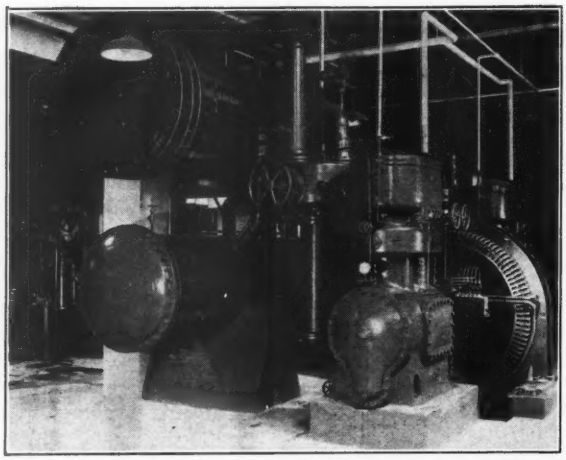


Fig. 2. A compact arrangement for cooling water in an air conditioning system in Washington, D. C. The compressors are duplex-coupled to the synchronous motor between them, and both discharge into the shell condenser, from which the liquid Freon-12 is circulated by a pump to the spray-type water cooler above.

Ammonia can also escape into the water circulated through the condensers and the cylinder jackets, as well as into any brine or water being cooled. Periodic checking is the best way to prevent such leaks. The jacket water will get hot if any considerable amount of ammonia is being dissolved in it. When making up pipe joints, leakage is invited if the threads are not properly cleaned with gasoline and steel wool, and then thoroughly dried, before the litharge is applied. To prevent submerged coils from rusting through at the threads, it is well to have a section of extra-heavy pipe welded to each end. The solder formerly used for fastening flanges has yielded to litharge joints, which in turn are being superseded by welding, whenever the job merits it.

A safety relief valve that has been made to blow off repeatedly from high pressure is likely to be an unnoticed source of leakage if it discharges through a pipe leading to the roof, where the pipe is capped with a diffuser. The writer once ended a search for an ammonia leak which had lasted for days by discovering a flanged joint buried in the concrete of the floor; the concrete had been poured while the bolts on this flange were only partly tightened. By keeping water running over the spot from a hose it was possible to chip out the concrete and stop the bubbling of the ammonia. Pumping out the line would have drawn air into the system.

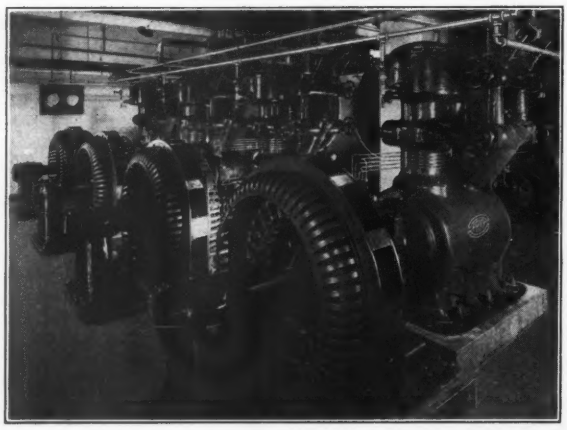


Fig. 3. These four 12-in. by 12-in. ammonia compressors deliver 1000 tons of refrigeration for air conditioning the Philcade and Philtower Buildings, in Tulsa. Spray-type water cooler appears at the extreme right

Breaking into old pipe lines when making alterations generally means a loss of ammonia, unless the shut-off valves are in good condition. Unpredictable accidents, such as the explosion of a flywheel or the failure of a joint, often account for heavy losses; these show up in the averages compiled from the experience of a number of plants.

The current edition of the Refrigerating Data Book, published by the A.S.R.E., presents a valuable table giving the average amounts of ammonia consumed in 76 ice plants, the records extending over a 4 yr. period. These plants (43 in New York, 16 in Philadelphia, 11 in Boston, and 6 each in Baltimore and Washington) were under capable management, and had an average loss of only 0.0516 lb. of ammonia per ton of ice made. The best yearly record was made by the Washington group, which used 0.0245 lb. per ton: the worst figure was 0.1300 lb., made the same year (1931) by the same number of plants in Baltimore.

Multiplying the average loss by the tons of ice made in a year and dividing by the total charge of ammonia (times 100) will show that these plants were replacing about 5 per cent of their supply of refrigerant. Similar calculations covering the experience of other and smaller plants having a variety of loads makes it clear that 10 per cent loss is not too high for an average system without all the supervision and accessories for preventing the escape of ammonia.

On the other hand, ammonia refrigerating equipment has now been developed to the point where the replacement of ammonia is generally a small item, in relation to the cost of power or of labor or of interest on the investment. A 30-t. ammonia machine in Baltimore has been cooling water for air conditioning a theatre for the past six seasons with an over-all cost for maintenance of less than $16 a year; this includes oil, ammonia, packing, parts replaced, painting, and the mechanics' time! This machine runs under full automatic control.

It is not unusual for a plant to be operated for months or years without anyone's feeling the need for replacing the ammonia, until the level gets so low in the receiver that the liquid seal is lost. By this time a large proportion of the original charge may be gone.

Freon

Freon-12 is of course harder to hold than ammonia, and a plant losing as little as 15 per cent of its charge of Freon-12 each year is doing well. The amount of Freon-12 needed in a system is reduced if coolers of the spray type can be employed, as these operate more nearly on the flash principle. The same kind of shell-and-tube water cooler is now being used in some cases with ammonia, to reduce the charge required.

One of the inconsistencies of our times is the regulation calling for the use of Freon-12 machines on air conditioning work, where the Freon-12 compressors are installed in the same engine room with ammonia machines which have for years been working dependably and safely—and which continue to do so!

New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Phosphate Comparator Set

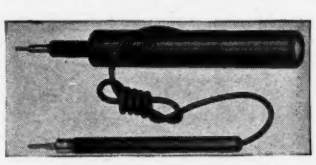
THIS simplified comparator made by W. H. & L. D. Betz, 235 W. Wyoming Ave., Philadelphia, Pa., is an adaptation of the colorimetric method of determining soluble phosphate, and is designed for compactness, utility, and appearance. The set is complete, consisting of a wooden cabinet, removable comparator block with two permanent (maximum and minimum) color standards, two graduated mixing tubes with

rubber stoppers, two graduated test tubes, one 20 cc. vial and graduated pipette. One extra graduated pipette and nipple, one 2-in. funnel with extra long stem, one box No. 5 Whatman filter paper, one 16-oz. bottle Molybdate Reagent, one 1-oz. bottle Stannous Chloride (Concentrated), together with complete instructions. The net weight complete is 5 lb. The Betz Junior Phosphate Comparator Set, as it is called, is regularly furnished with two standards (30 to 60 p.p.m.), permitting control of phosphate within that range. Standards of 20 and 40, or any other specified ranges, can be supplied on request.

New Safety Test Lamp

THE SITTLER CO., 1133 West Van Buren St., Chicago, Ill., has introduced a new type test lamp and voltage indicator which is being distributed under the trade name SG-100 Test Lamp. It can be used on AC or DC circuits from 110 to 600 v. and comes packed in durable carrying case with belt loop.

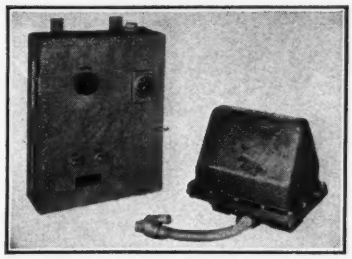
The large test prod holder contains a 5000 ohm 20 watt capacity resistor of single layer Nichrome wire wound on



porcelain core coated with vitreous enamel. The lamp socket, with long-life filament Mazda lamp and magnifying bull's-eye, is wired above resistor, with the single test lead wired to side of lamp socket. The 5000 ohm resistor and lamp filament are wired in series between test prods. Excessive voltage burns out lamp filament. Current values are in milliamperes; a 110-v. circuit indicates about 20 milliamperes light value through the tester; 220 v., about 40; 440 v., about 80; and 600 v., about 110 milliamperes.

Explosion Proof Vibrator

THE SYNTRON CO., 494 Lexington Avenue, Homer City, Pa., have just added to their line of vibrators an explosion proof model. The vibrator, a heavy, pulsating electro-magnet, is fully encased in a thick, electric-furnace steel

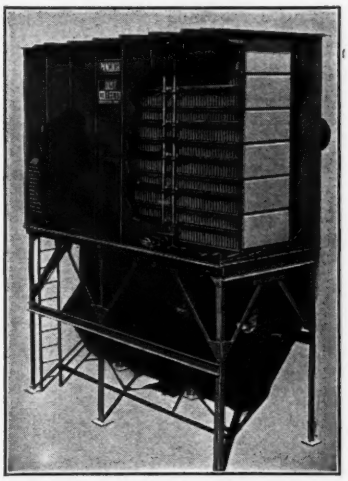


case, with ground joints, and with an armored cable lead. The remote electric control panel containing a rectifier, operating switches and rheostat for controlling the vibrator's power, is fully encased in a cast iron case, with ground joints and approved explosion proof fittings.

Dust Collector

PANGBORN CORP., Hagerstown, Md., announces the Type CH all metal screen dust collector made in three types. In the section type system the exhauster is connected to the clear side of the collector placing the entire system under suction and discharging the cleaned air to the atmosphere or working room. In the pressure type system the fan blows the dust to the collector thus putting it under pressure. The two-section continuous collector is for systems handling average dust concentrations where operations cannot be periodically interrupted for short periods to permit screen vibrations. A spark arrester is necessary for grinding or polishing operations or when linty materials are collected and may be added ahead of and integral with the collector.

Dust-laden air enters the rear of the collector where, striking a baffle plate,



a reduction in velocity occurs, dropping the heavier particles directly to the hoppers. The finer particles are conveyed to the dust side of the cloth screens, retained thereon, the cleaned air filtering through the cloth, passing out through the clear air end of the screens into the clear air chamber and exhausted through the outlet.

Cock Gage

MERCO NORDSTROM VALVE CO., 400 Lexington Ave., Pittsburgh, Pa., has developed a leakproof gage cock which can be completely opened or closed with ¼ turn. This gage cock has a rated working pressure for water, oil and gas of 2000 lb. It has a stainless steel plug and a forged steel body.

Stick lubricant is inserted under a lubricant screw which can be turned down. Turning of the screw transmits hydraulic pressure to the seat, and in the event the cock becomes hard to turn, the pressure exerted will loosen it. Special lubricants are available for steam. It is made in ¼ and ⅜ in. sizes and is wrench-operated.

Capacitor

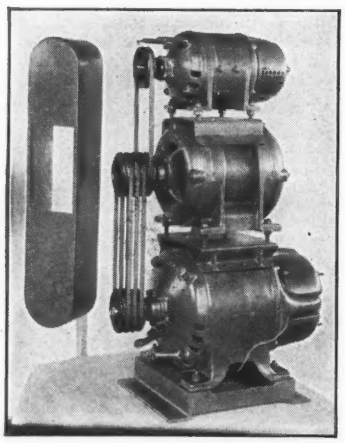
CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J., announces the Type FA capacitor made for working voltages up to 35 volts in a variety of capacity values up to 2000 mfd. These units are made up in cylindrical aluminum cans with Bakelite terminal caps into which screw terminals are moulded. Over this assembly is a cardboard insulating sleeve. Through a process of

double ageing and rigid chemical control unusually stable characteristics and uniform performance are obtained.

Pyramid-Mounted Motor Generator Set

A NEW Pyramid-Mounted arrangement of three-machine motor-generator sets has been developed at the Norwood, Ohio, Works of Allis-Chalmers Mfg. Co. The generator, motor and exciter, each a self-contained machine, are assembled one above the other, thus requiring floor space equal only to the generator mounting dimensions. On top of the generator is placed the induction motor, securely attached with suitable base plate, and the exciter in like manner is mounted on top of the motor. The generator and exciter are driven by Texrope V-belts from the motor shaft, adustment being provided in the motor and exciter base plates. Motor-generator sets of this type are at present available in sizes up to and including 10 kw. Each machine of the set is self contained and readily removable as a separate unit.

In the pyramid arrangement also machines of different speeds may be used.



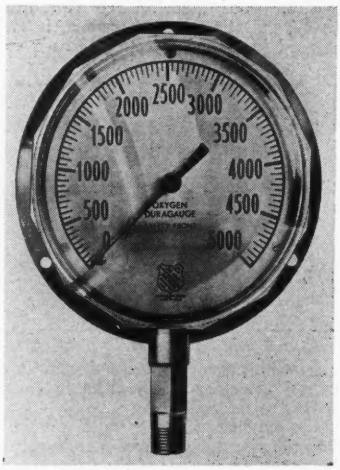
Thus a direct current generator of standard speed may be used with a 25 cycle, 50 cycle (or any other frequency) induction motor by merely using the corresponding required speed ratio in the Texrope V-belt drives.

Buchi Superchargers

ELLIOTT Co., Jeannette, Pa., has acquired from Dr. Alfred J. Buchi of Winterthur, Switzerland, a license to manufacture superchargers for use with the patented Buchi supercharging system, and in accordance with Buchi design patents. The field of application covered by the license agreement includes four-stroke-cycle internal combustion engines for stationary, marine and traction purposes. The superchargers, commonly called turbochargers, are turbine-driven centrifugal blower units and are used to scavenge and supercharge four-stroke-cycle internal combustion engines. The turbine is propelled by the exhaust gases from the engine in an ingenius manner which obtains maximum benefits from the energy in the exhaust gas.

Oxygen Duragauge

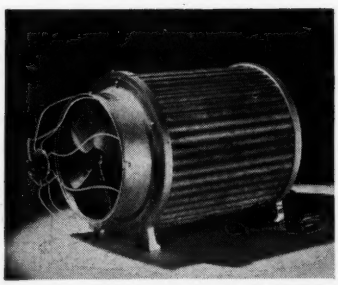
AMERICAN GAUGE DIVISION of Manning, Maxwell & Moore, Inc., Bridgeport, Conn., announces a new special oxygen Duragauge for high pressure oxygen service. The case is a heavy brass casting with a safety solid front and a



full open back. The back of the gage is sealed with moisture-proof paper protected by a thin brass disc. Mounting lugs on the case held it away from the wall. The Bourdon tube is byrellium copper, and the socket is forged bronze. No steel is used for the sake of safety. Accuracy is guaranteed to within ½ of 1 per cent. The new, clear-as-crystal gage cover of transparent plastic opens up the dial for easier reading.

Odor Adsorber

EMPLOYING the principle of the ordinary gas mask, a newly invented portable odor adsorber, is now available for removing unpleasant odors, gases, vapors, smoke and fumes from theaters, restaurants, offices, factories, hospitals, lavatories and other places of human occupancy. The device, known as the Dorex "Squirrel Cage" Odor Adsorber, has an electric motor-driven fan which draws

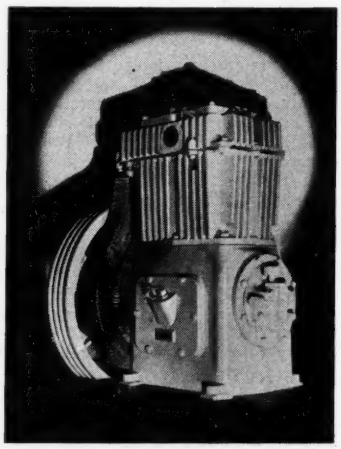


the foul air in and delivers purified air back into the room, after the odorous and gaseous impurities have been removed. The adsorption medium is composed of a specially processed, highly activated, granular, coconut shell carbon.

Two types of these new units are offered by the makers—The Dorex Division of the W. B. Connor Engineering Corp., 114 East 32nd Street, New York —one for installation on any wall or ceiling where it occupies little more area than an ordinary fan, and the other to be applied to any existing ventilating or air conditioning systems.

Pressure Lubricated Air Compressors

TWO NEW pressure lubricated air compressors, Models 244 and 340, especially designed for heavy duty industrial use, are announced by the Quincy Compressor Co., Quincy, Ill. Model 244 is a



duplex cylinder, single stage compressor with a maximum piston displacement of 45.7 c.f.m. Model 340 is a two stage compressor having 40.0 c.f.m. maximum displacement.

AS A RESULT of research into the merits of various compositions, The B. F. Goodrich Company, Akron, Ohio, is now offering a new synthetic coating for belting covers, which on the basis of its tests, will greatly reduce the effects of aging. Samples of conveyor belting with covers under severe tension were coated with the synthetic composition, and exposed for six months to all varieties of weather. At the end of that period none of the samples of belting on which the new coating had been applied showed any evidences of cover deterioration.

Reverse Flow condenser of internal air cooler type arranged for two passes of water flow; assembled for shop test with its twin element, two stage steam jet air ejector.

Steam Condensing Systems

Practical condensing systems for industrial plants have been developed to return highest results, on an annual basis, from the original investment.

The highly effective, low priced reverse-flow condenser using relatively long tubes, is one of the important factors in reducing cost while maintaining performance. Greater capacity is obtainable from steam jets than ever before and freedom from repairs and maintenance has followed the modern methods of applying inter- and after-condensers.

In addition to condensing and vacuum apparatus, complete water handling equipment has been developed and refined during the past 30 years, including circulating and condensate pumps, evaporators (including largest in the world for Ford Motor Co.), feed water heaters (Lockhead construction for pressures of 4000#/sq. in.) and cooling towers of mechanical and natural draft type.

FOSTER WHEELER CORPORATION, 165 Broadway, New York, N. Y.

FOSTER WHEELER

Modern Pioneers Receive Recognition

Through a nationwide series of events sponsored by the National Association of Manufacturers, living inventors, scientists and research workers were given awards commemorating their service to society.

PERHAPS because two of America's most admired presidents were born in the month of February and their anniversaries are celebrated annually, Americans have come to look upon that month as the most appropriate time of the year for bestowing honors upon deserving individuals, particularly upon those whose achievements have been of outstanding benefit to people as a whole. Be that as it may, this year which marks the 150th anniversary of the founding of the United States Patent System the National Association of Manufacturers chose the month of February for conducting a nationwide tribute to the living inventors and scientists who within the past 25 yr. have contributed to industry ideas and patents that have in general been of social and economic value to the people of the United States. In many cases inventions or discoveries have been the result of group effort and their accomplishments were not overlooked for many who have collaborated closely as inventors or research workers with the patentee or patentees were recipients of scroles in recognition of their services.

The Committee on Modern Pioneer Awards was not a committee of the National Association of Manufacturers, but a wholly independent group of eminent scientists selected because of their wide experience and sound judgment. The members were: Karl T. Compton, President of the Massachusetts Institute of Technology, Chairman; Forest R. Moulton, Secretary of the American Association for the Advancement of Science; George B. Pegram, Dean of the Graduate Facu'ties of Columbia University; John T. Tate, Dean of the College of Science, Literature and the Arts of the University of Minnesota; Edward R. Weidlein, Director of Mellon Institute; and Frank C. Whitmore, Dean of the School of Chemistry and Physics of Pennsylvania State College.

Somewhat over 1000 names were put in nomination for Modern Pioneer awards from which about 500 were chosen to be the recipients. These awards were presented at dinners held during the month in fifteen different industrial areas of the country. Although space does not permit publishing here the entire list of recipients a careful selection of those whose work affects the power plant field directly has been made and their names are listed in the following paragraphs, divided into areas where the presentations were made.

National Honors

Those selected for national honors were presented with their awards in New York City on February 27, at the same time Modern Pioneer Certificates were given to those selected from the New York area. Because of the wide ramifications of their work, the entire list of recipients of national honors is given here while the listing of New York area selections is given later in the chronological order in which the area dinners were held:

Dr. Edwin Howard Armstrong, Professor of Electrical Engineering, Columbia, University; Dr. Leo Hendrik Baekeland, President The Bakelite Corporation; Dr. William Meriam Burton, Ex-Pres. Standard Oil Company of Indiana; Willis Haviland Carrier, Chairman of the Board, Carrier Corporation; Dr. William David Coolidge, Director of Research Laboratory General Electric Co.; Dr. Frederick Gardner Cottrell; Dr. George Oliver Curme, Jr., Vice Pres. Carbide & Carbon Chemicals Corp.; Dr. Lee De Forest; John Van Nostrand Dorr, Pres. The Door Co., Inc.; Henry Ford, Pres. Ford Motor Co.; Charles Franklin Kettering, Vice Pres. General Motors Research Corp.; Edwin Herbert Land, Pres. Polaroid Corp.; Dr. Irving Langmuir, Associate Director Research Laboratory General Electric Co.; Dr. Harry Steenbock, Professor of Biochemistry The University of Wisconsin; John B. Tytus, Vice Pres. in Charge of Operations American Rolling Mill Co.; Charles Frederick Wallace, Vice Pres. Wallace & Tiernan Co., Inc.; Orville Wright; Dr. Vladimir Kosma Zworykin, Research Engr. RCA Manufacturing Co.; NYLON group from E. I. du Pont de Nemours & Co.: Willard E. Catlin, Donald D. Coffman, Winfield W. Heckert, Benjamin W. Howk, George D. Graves Wilbur A. Lazier, John B. Miles, Jr., Wesley R. Peterson, Frank K. Signaigo and Edgar W. Spanagel.

Cleveland Area

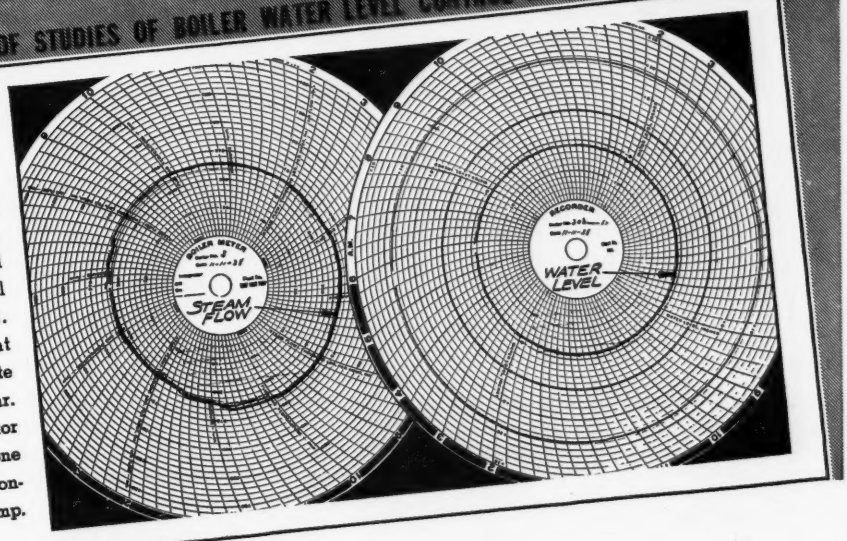
To honor the Modern Pioneers in the Cleveland area the dinner at which 32 certificates were presented was held on February 7. A selected list of recipients follows:

Joseph Becker, Doctor of Engineering, Vice Pres. & Construction Div., Koppers Co.; Tracy V. Buckwalter, Vice Pres., The Timken Roller Bearing Co.; Arthur Foster Case, Consulting Engr., The Wellman Engineering Co.; Dr. Frank Conrad, Asst. Chief Engr., Westinghouse Elec. & Mfg. Co.; Ralph Emmons Hall, D.Sc., Director, Hall Laboratories, Inc.; John K. Hodnette, Electrical Engr., Westinghouse Elec. & Mfg. Co.; Samuel B. Kraut, Electrical Engr., Westinghouse Elec. & Mfg. Co.; James Finney Lincoln, Pres., The Lincoln Electric Co.; John Cromwell Lincoln, Chairman of the Board of Dir., The Lincoln Electric Co.; Dr. Walther Mathesius, Vice Pres., U. S. Steel Corp.; Marvin Pipkin, Chem. Engr., General Electric Co., Lamp Development Laboratory, Nela Park; Waldo Lonsbury Semon, Res. Chemist, The B. F. Goodrich Co.; Williame Clyde Stevens, Mach. Designer, Firestone Tire & Rubber Co.; honorable mention: Harry Lloyd Benner, E. I. du Pont de Nemours & Co.

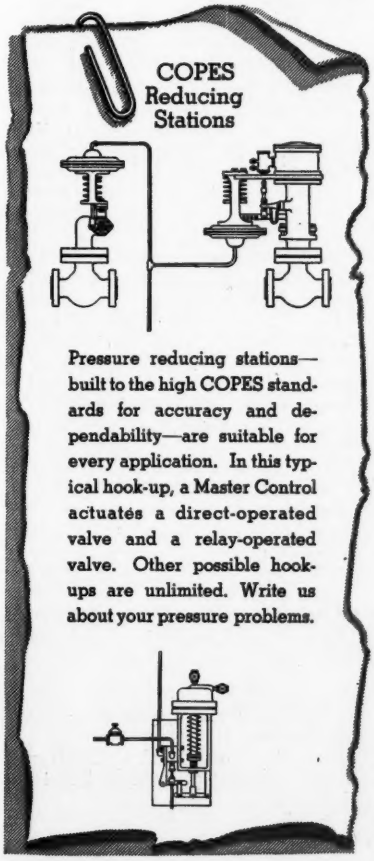
NO. 2 IN A SERIES OF STUDIES OF BOILER WATER LEVEL CONTROL WITH COPES FLOWMATIC

425 POUNDS W. S. P.

Gas-fired 425-lb. 725-deg. (ultimate operation at 860 lb., 830 deg.) B. & W. Integral Furnace Boiler tops original 400-lb. 600-deg. plant. Present loads constant at 65,000 lb. per hr. Ultimate peak, 200,000 lb. per hr. COPES Flowmatic Regulator holds water level within one inch. COPES governor controls the boiler feed pump.



★ Quickly, easily adjusted for any change in your plant conditions



Pressure reducing stations—built to the high COPES standards for accuracy and dependability—are suitable for every application. In this typical hook-up, a Master Control actuates a direct-operated valve and a relay-operated valve. Other possible hook-ups are unlimited. Write us about your pressure problems.

As accurate as your most sensitive instrument, as rugged as any equipment in your plant, the COPES Flowmatic compensates automatically for any temporary changes in your plant conditions. Not even a sudden change in drum pressure from any cause upsets the feed water flow or water level control. And if your conditions are permanently changed, it's a simple matter to adjust the COPES Flowmatic for the new conditions without calling on factory experts. Bulletin 417 tells how operators in one plant completely re-adjusted their Flowmatic in only 30 minutes without supervision. Write for this interesting bulletin.

NORTHERN EQUIPMENT CO., 302 GROVE DRIVE, ERIE, PA.

Feed Water Regulators, Pump Governors, Differential Valves
Liquid Level Controls, Reducing Valves and Desuperheaters

BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY AND ITALY
REPRESENTATIVES EVERYWHERE

★ GET CLOSER LEVEL CONTROL WITH THE FLOWMATIC

Minneapolis Area

Committee selections from the Minneapolis area totalled only seven inventors to receive Modern Pioneer certificates. These were presented on February 7, and among them the only one of prominence in the power plant field is Frederick S. Denison, Engr., Minneapolis-Honeywell Regulator Co.

San Francisco Area

Twenty-three inventors in the San Francisco area were chosen by the Committee on Awards to receive certificates or joint awards as Modern Pioneers on February 14. Only two of these, however, are indicated as having contributed to the power field, these are:

Edwin Letts Oliver, Pres., Oliver United Filters, Inc.; and Ernest J. Sweetland, Ch. of Bd., Oliver United Filters, Inc.

Detroit Area

Inventors chosen for Modern Pioneer awards in the Detroit area were given their certificates on February 15. A total of 44 were thus honored, of which the following is a selected list:

R. L. Beers, Chief Engr. and Vice Pres. in charge of Engineering, Detroit Stoker Co.; A. J. Fisher, Engineer, General Motors Corp.; Charles F. Kettering, Vice Pres. and Director, General Motors Research Corp.

Hartford Area

February 16 was the date chosen for honoring the Modern Pioneers in the Hartford area. In all, 13 inventors were chosen by the committee to receive certificates, the following have contributed to the power plant field:

Fernley H. Banbury, Engr., Farrell Birmingham Co., Inc.; Walter Frederick Herold, Stowart Warner; John Cargill Shaw, Engineer, Pratt & Whitney; honorable mention, Wallace E. Brown, E. I. du Pont de Nemours & Co.

Los Angeles Area

The Los Angeles area, on February 16, honored only nine of its residents as Modern Pioneers, but among the list is noted Lloyd F. Hunt, Protection Engr., Southern California Edison Co., Ltd. Joint awards were presented to Evald Anderson, Technical Dir., Walter August Schmidt, Pres. and Gen. Mgr., and Harry Valentine Welch, Dir. and Chief Chemist of the Western Precipitation Corp.

Philadelphia Area

For the presentation of 24 individual, and 100 group and honorable mention awards, the Philadelphia area held its dinner in honor of the Modern Pioneers on February 16. From this long list, power engineers will be interested in knowing that the following have been honored:

Newcomb Kinney Chaney, Dir. of Research, United Gas Improvements Co.; Philip Hartley Chase, Chief Engr., Philadelphia Electric Co.; Thomas Randolph Harrison, Tech. Dir., The Brown Instrument Co.; Francis Hodgkinson, Consulting Mech. Engr., Westinghouse Electric & Mfg. Co.; Dr. Russell Pearce Heuer, Vice Pres. in charge of Research, General Refractories Co.; Albert Kingsbury, Pres., Kingsbury Machine Works, Inc.; Morris E. Leeds, Chairman of Board, Leeds & Northrup Co.; David Chandler Prince, Chief Engineer, General Electric Co.; William K. Rankin, Development Engineer, General Electric Co.; Henry Frederick Schmidt, Consulting Engr., Westinghouse Elec. & Mfg. Co.; and Clarence H. Thayer, Engr., Sun Oil Co.

Baltimore Area

On February 19, the following list of inventors selected from a total of 23 because of their work in the power plant field were presented with Modern Pioneer certificates at a dinner held in Baltimore:

Dr. F. G. Cottrell; Gustave Fast, Pres., The Fast Bearing Co.; A. L. Penniman, General Supt. Electric Div., Consolidated Gas, Electric, Light & Power Co.; A. Herman Pfund, Prof. of Physics and Head of Dept., Johns Hopkins University; F. E. Ricketts, Vice Pres., Consolidated Gas, Electric Light & Power Co.; joint awards: P. L. Betz, Research Engineer and S. Karrer, Director of Research, Consolidated Gas, Electric Light & Power Co.; Leon A. Graybill, Res. Dept., Firestone Tire & Rubber Co., and Russell B. Newton, Supt. of Columbus, Ga., Mill, Bibb Manufacturing Co.

St. Louis Area

Among the total of 25 inventors honored as Modern Pioneers at St. Louis on February 19, the following have made noteworthy achievements useful to men in the power plant field:

Fred B. Adam, Pres., Frank Adam Electric Co.; John N. Carothers, Dir. of Research, Monsanto Chemical Co.; Burns Dick, Chief Engr. in chg. of Automotive Div., Wagner Elec. Corp.; Lowell Cleland Hewitt, Dir. of Research, Laclede-Christy Clay Products Co.; William D. Moore, Pres., American Cast Iron Pipe Co.; and Edwin S. Pillsbury, Pres., Century Electric Co.

Rochester Area

In the Rochester area a total of 59 Modern Pioneer certificates were presented on February 19. Included among the recipients were:

Willis Haviland Carrier, Chairman of the Board, Carrier Corp.; Dr. William Hale Charch, Rayon Department, Technical Division, E. I. du Pont de Nemours & Co.; Albert A. Criqui, Chief Engr., Buffalo Forge Co.; William Chauncey Geer, Vice-President., The B. F. Goodrich Co.; Raymond Ronald Ridgeway, Dir. of Abrasive Res., Norton Co.; Eugene Cornelius Sullivan, Dir. of Research Dept. and Vice Chairman of Board, Corning Glass Works; William C. Taylor, Chief Chemist, Corning Glass Works; and Frederick William von Meister, Executive Vice Pres., Ozalid Corporation.

Boston Area

In Boston a total of 29 certificates and joint awards were presented on February 20. Those whose work is prominent in the power plant field are:

Roger W. Andrews, Sales Mgr., Riley Stoker Corp., James L. Cox, Engr., Hygrade Sylvania Corp.; Alfred Victor de Forest, Professor, Mechanical Engineering Dept., Massachusetts Institute of Technology; Harold Frederick Hagen, Vice Pres. and Dir. of Res., B. F. Sturtevant Co.; Thure Larsson, Mechanical Engr., Norton Co.; Albert J. Loepsinger, Engr., Grinnell Co.; Clesson E. Mason, Dir. of Control Research, The Foxboro Co.; Henry E. Warren, Pres., Warren Telechron Co., Edward Goodrich Watkins, Pres., Simplex Time Recorder Co.; Edward R. Wolfert, Section Engr., Westinghouse Elec. & Mfg. Co.; Joint awards: John F. White, Research Chemist and William S. Wilson, Dir. or Research of the Monsanto Chemical Co.; and honorable mention to Francis Leroy Fennel, E. I. du Pont de Nemours & Co.

Chicago Area

From a total of 61 Modern Pioneers who received certificates at the dinner given in Chicago on February 20, the following have been selected for listing here:

Joseph George Alther, Vice Pres., Universal Oil Products Co.; Harry H. Barber, Pres., Barber-Greene Co.; David Pryce Davies, Vice Pres. in Charge of Engineering, J. I. Case Co.; Carbon P. Dubbs, Consultant, Universal Oil Products Co.; Gustav Egloff, Dir. of Res., Universal Oil Products Co.; Lewis Martin Ellison, Pres., Ellison Draft Gage Co.; Alfred L. Eustice, Pres., Economy Fuse & Mfg. Co.; John Mayer Frank, Pres. and Gen. Mgr., ILG Electric Ventilating Co.; Walter Geist, Vice Pres., Allis-Chalmers Mfg. Co.; Roscoe Henry George, Res. Engr., Purdue University Research Foundation; Laurens Hammond, Pres., Hammond Clock Co.; Joseph Harrington, Pres. and Gen. Mgr., Harrington Heater Co.; Walter Frederick Herold, Vice Pres. and Chief Engineer, Bassick Div., Stewart-Warner Corp.; George Alexander Hughes, Pres., Edison General Elec. Appliance Company, Inc.; Professor N. Vladimir Ipatieff, Dir. or Chemical Research, the Universal Oil Products Co.; Major Adolph Langsner, Chief Engineer, Eugene Dietzgen Co.; Sern Madsen, Engr. and Res. Dir., Curtis Companies, Inc.; Ira E. McCabe, Chief Engr., Mercoid Co.; Jacque Cyrus Morrell, Assoc. Dir. of Res., Universal Oil Products Co.; Ray C. Newhouse, Engr., Allis-Chalmers Mfg. Co.; Thomas Hunton Rogers, Assoc. Dir., Standard Oil Co. (Indiana), Whiting Research Laboratory; L. R. Smith, Chairman of the Board, A. O. Smith Corp.; William Halvor Taylor, Engr., The Vilter Manufacturing Co.; Vanderveer Voorhees, Development and Patent Department, Standard Oil Co. (Indiana); Cary Richard Wagner, Chief Chemist, The Pure Oil Co.; Dr. William M. White, Engr., Allis-Chalmers Mfg. Co.; Elmer Elsworth Woodward, Pres., Woodward Governor Co.; joint awards: William D. James, Pres., George T. Markey and John B. Olson, Supv. of Experimental & Development Dept., James Manufacturing Co.

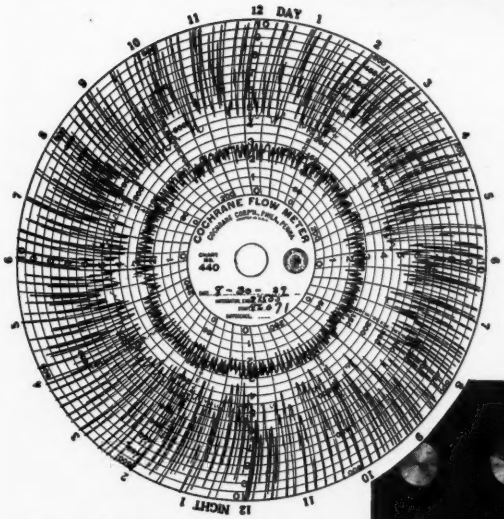
Cincinnati Area

Those honoring the Modern Pioneers in this area held their dinner on February 21, at which 25 inventors were given certificates. The selected list follows:

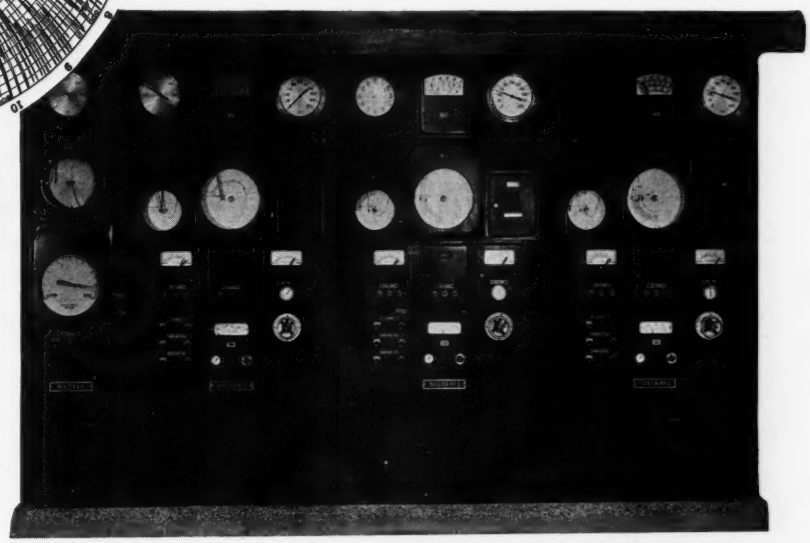
William A. Chryst, Consultant Engr., Delco-Products Div., Gen. Motors Corp.;

Abrupt Load Changes

Occur at Baldwin Rubber Company's new steam plant —yet Cochrane Flow Meters accurately record steam flow continuously . . . .



Above is a typical Cochrane Flow Meter chart showing the abrupt changes in the steam flow which swings over a 3 to 1 range six to ten times per hour. At the right is shown the panel board on which are mounted three recording and integrating Cochrane Flow Meters (one with pressure recording element).



The Hunter Co., Engineers

Other Cochrane Equipment at Baldwin Rubber Company:

Continuous Blow-off System recovering heat from boiler blow-off water.

10" Multiport Relief Valve for 10 lb. operating pressure.

10" Steam Purifier handling 60,000 lb. per hour at 135 lb. pressure.

2" Drainer removing water slugs recovered by Cochrane Purifier.

WHEN the Baldwin Rubber Company of Pontiac, Mich. decided to expand their power plant to meet the constantly increasing demands for process and heating steam, their engineers were instructed to "design a plant and select the equipment that would, without extravagance, best meet the requirements."

Three new 400 h.p. stoker-fired steam generators replaced the old boilers and new auxiliary equipment was installed. One unusual characteristic of the plant is a variation in steam flow rate from 8500 to over 25000 lbs. and from six to ten times per hour.

Three Cochrane Electric Flow Meters record these steam flow changes and one records pressure as well. Cochrane Electric Flow Meters, sensitive to the slightest variation in flow, yet rugged enough to stand such continuous operation, are particularly suited to installations such as this one.

The combination of exceptional measuring sensitivity with a sturdy operating mechanism is a peculiar Cochrane characteristic based on its unique galvanometer null principle—insuring accurate registration without variation, lag or hysterisis. Write for complete details on this remarkable instrument.

COCHRANE CORPORATION . 3123 N. 17th Street . Philadelphia, Pa.

COCHRANE

WATER SOFTENERS • DEAERATING HEATERS • FILTERS • BLOW-DOWN EQUIPMENT • VALVES • FLOW METERS

Harold William Greider, Dir. of Res., The Philip Carey Manufacturing Co.; Jerome Martin, Dir. of Res., Commercial Solvents Corp.; Thomas Willett Rolph, Chief Engr., Holophane Co., Inc.; Games Slayter, Vice Pres. in charge of Res. & Dev. of Fiberglas, Owens-Corning Fiberglas Corp.; L. A. Stengel, Chemist Commercial Solvents Corp.; joint awards: Harald W. de Rapp and Harry C. Hetherington of E. I. du Pont de Nemours & Co.

NEW YORK AREA

As stated previously, presentation of Modern Pioneer certicates to recipients in the New York area was made February 27 at the same dinner when National Awards were conferred. From among the 58 individual and 41 joint recipients in this area, the following selection has been made because of their achievements in the power field:

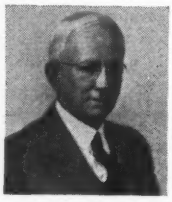
Dr. John C. Baker, Chief Chemist, Wallace & Tiernan Co.; Dr. Frederick M. Becket, Consultant, Union Carbide & Carbon Corp.; Dr. William David Coolidge, Dir. of Res. Laboratory, General Electric Co.; John Van Nostrand Dorr, Pres., The Dorr Co., Inc.; Gano Dunn, Pres., The J. G. White Engineering Corp.; George Herbert Gibson, Consulting Engr.; William Nelson Goodwin, Jr., Chief Engr. & Dir. of Res., Weston Electrical Instrument Corp.; Dr. David Schenck Jacobus, Advisory Engr., The Babcock & Wilcox Co.; Lester Kirschbraum, Vice Pres., The Flintkote Co.; Irving Langmuir, General Electric Co.; Max Spillman, Engr., Worthington Pump & Machinery Corp.; Christian Steenstrup, Engr., General Electric Co.; Howard George Walker, Mfg. Engr., Western Electric Co., Inc.; Charles Frederick Wallace, Vice Pres., Wallace & Tiernan Co., Inc.; Willis R. Whitney, Vice Pres., in charge of Res., General Electric Co.; joint awards, Earle C. Pitman, E. I. du Pont de Nemours & Co.; John Francis Grace, Engr. and Thomas Canning McBride, Engr. of Worthington Pump & Machinery Corp.; George Dolan, Elec. Engr. and Harry B. Smith, Const. Supt. of United Engineers & Public Service.

News from the Field

Alex Dow Retires

ALEX DOW, who through half a century of hard and conscientious work deserves the well earned title of "Dean of the Utility Industry" retired as president of The Detroit Edison Co. following the annual stockholders meeting in New York, Feb. 5. While out of the active operating end he will remain in a consulting capacity as chairman of the executive committee. Alfred C. Marshall who has been vice president and general manager since 1923 follows Mr. Dow as president and it is not expected that the change will involve either the policy or operation of the corporation.

Alex Dow



Alfred C. Marshall

Mr. Dow, now 78 yr. old, came to this country from Scotland in 1882, worked for the B. & O. Railroad and the Brush Electric and in 1896 went to Detroit as vice president and general manager of the Edison Illuminating Co., predecessor of The Detroit Edison Co. Progressive, building on a sound basis of honest service he piloted his company to the forefront of the utility industry and remained to the end what he liked to term an "operator".

Mr. Marshall was born 1872 at Middleton, O., graduated in engineering from the University of Michigan, and worked for the city of Detroit from 1894 to 1899. He was chief engineer for the Rapid Railway interurban service and in 1904 joined The Detroit Edison Co. as construction engineer. The next year he went to Port Huron as general manager of the Port Huron Light & Power Co. but returned to Detroit in 1911 as assistant to the president of the Eastern Michigan Edison Co. In 1913 he went back to The Detroit Edison Co. as vice president and became general manager in 1923.

Polhemus Succeeds Griffith in Northwest

JAMES H. POLHEMUS, for the past four years Executive Vice-President of Portland Electric Power Company and its affiliates, Portland General Electric Company and Portland Traction Company, has been elected President of Portland General Electric Company to succeed Franklin T. Griffith, who becomes Chairman of the Board of Directors.

Mr. Griffith's resignation as President of Portland General Electric Company was submitted at the meeting of the Board of Directors February 7, the day after his 70th birthday, and Mr. Polhemus assumed his duties as of March 1.

James H. Polhemus

Franklin T. Griffith

Mr. Griffith, who has been associated with the company and its affiliates for 46 years as attorney, general counsel, and president, will continue active in its affairs as chairman of the board.

Mr. Polhemus was graduated from Stanford University in civil engineering in 1911 and immediately began his active career as an engineer.

FERDINAND G. SEULBERGER has been appointed as Professor of Cooperative Education and Director of Industrial Relations in the Technological Institute of Northwestern University. He will develop contacts with industrial firms in the middle west, and arrange for the placement of students who, under the cooperative plan of education, will alternate between classroom study and industrial jobs on a three months' basis.

AMERICAN CHEMICAL SOCIETY will hold its ninety-ninth meeting in Cincinnati April 8 to 12. Dr. Alfred Springer has been appointed honorary chairman of the convention and Procter Thomson is general chairman.

ACCORDING to an announcement made by H. W. Prentis, Jr., president, National Association of Manufacturers, R. E. Howe, president, Appalachian Coals, Inc., has accepted appointment as a member of the Committee on Principles of Americanism of the National Association of Manufacturers.

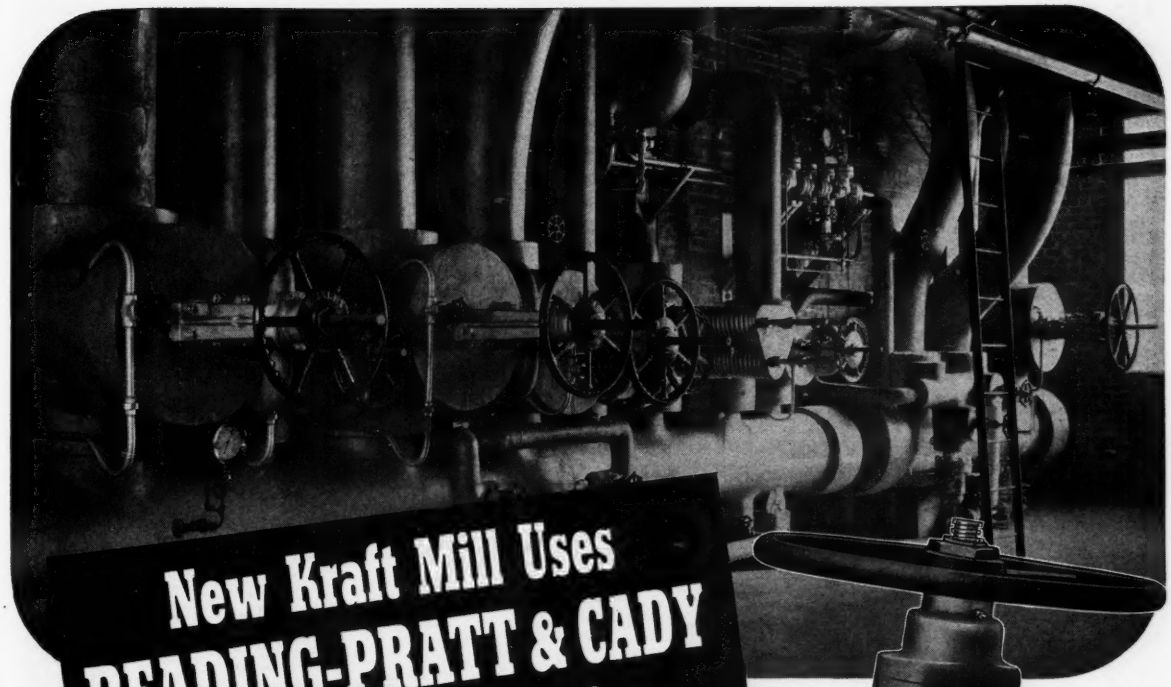
THE Industrial Unit Heater Association at the Annual Meeting in Cleveland, Ohio, on January 22, 1940, elected C. C. Cheyney, President; Albert J. Nesbitt, Vice President; and L. O. Monroe, Secretary-Treasurer for the ensuing year.

R. E. HESS, Assistant Secretary of the American Society for Testing Materials, 260 So. Broad St., Philadelphia, Pa., announces the Society's calendar of meetings for 1940 as the following: Spring Meeting, March 6, Hotel Statler, Detroit, Mich.; A.S.T.M. Committee Week, March 4 to 8 inclusive, Hotel Statler, Detroit,, Mich.; Forty-third Annual Meeting, June 24 to 28, inclusive, Chalfonte-Haddon Hall, Atlantic City, N. J.

THE COMPANY NAME, Quaker City Rubber Company, has been changed to Quaker Rubber Corporation. This name has been qualified in all the states of the United States and foreign countries where this company is now doing business or may at some future date do business.

SPONSORED by the Power Maintenance Association of South Jersey, a three-day conference and exhibition will be held March 12, 13 and 14 in the gymnasium of the Camden County Vocational School, Camden, N. J. The exhibit will show the proper use of instruments to enable industry to minimize production, process and operating costs. Leading instrument manufacturers will participate and exhibit their newest refinements of instruments for industrial application.

DURING DECEMBER 1939 production of electrical energy in the U. S. reached an all-time high of 11,849,491,000 kw. hr. Of this 27 per cent was generated by water power, the balance from fuel using plants.



New Kraft Mill Uses READING-PRATT & CADY to Solve Valve Problems

● Gleaming turbines purr as the South builds for its people another industry of National importance—founded on one of its own natural resources. Great new mills make Kraft from Southern Pine.

●

Above is shown a header in the Power Plant of one of the more important of these mills—READING-PRATT & CADY 900 lb. Cast Carbon Molybdenum Steel Valves with Stellite Trim handling steam to the 4000 KW turbine.

The same mill solved most of its valve problems with READING-PRATT & CADY valves for the following services:

4000 KW and 3000 KW Turbines—supply and exhaust lines
Boiler Feed-water lines
Caustic lines
Black Liquor Concentrator lines
Boiler Room Auxiliary lines
Evaporator lines
Digestor lines
Diffuser Water lines

Write for READING-PRATT & CADY recommendations whenever you are discussing valves. You, too, will find they combine sound experience with modern engineering.

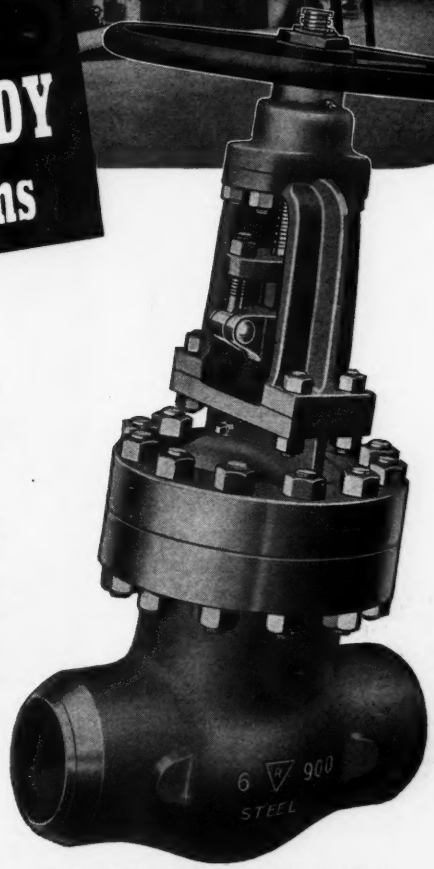


Fig. 9001. Cast Carbon Molybdenum Steel Gate Valve with Stellite Trim. Pressures to 900 lbs. and temperatures to 950°F.

READING-PRATT & CADY
READING-PRATT & CADY DIVISION · BRIDGEPORT-CONNECTICUT

AMERICAN CHAIN & CABLE COMPANY, Inc.

Allis-Chalmers Mfg. Co. Appoints Assistant Manager

DR. WILLIAM M. WHITE, manager and chief engineer of Allis-Chalmers Mfg. Company's Hydraulic Department, announces the appointment of H. P. Binder as assistant manager of the Centrifugal Pump Division. Mr. Binder, a graduate of the School of Electrical Engineering of Purdue University, was selected to enter the Allis-Chalmers Graduate Training Course in 1911. In 1912 he entered the Hydraulic Engineering Department where he served until 1917, at which time he joined the 9th Field Artillery of the regular army. At the conclusion of the war he resigned with the rank of captain, and returned to the Allis-Chalmers Co. in 1919. In the company's Centrifugal Pump Division he took up sales-engineering work, which required him to visit various Allis-Chalmers district offices to assist

H. P. Binder

salesmen on local problems. This work he continued until his appointment to the new executive post.

Obituaries

A. H. BLACKBURN, assistant sales manager of the Riley Stoker Corp. died in Worcester, Mass., on February 5. He was born in England in 1864, came to the United States in 1892 and was general manager and treasurer of the Green Fuel Economizer Co. from 1893 until 1914 when he became chief engineer of the Underfeed Stoker Co. of America. In 1922, when the Underfeed Stoker Company was absorbed by the Riley Stoker Corp., Mr. Blackburn became assistant manager of the company and later assistant sales manager, the position he held until his death.

COLONEL ARTHUR FARRAGUT TOWNSEND, Chairman of the Board of Raybestos-Manhattan, Inc., and General Manager of The Manhattan Rubber Mfg. Division, Passaic, N. J., died Sunday afternoon, January 14, at his desidence, 298 Greenway Road, Ridgewood, N. J., at the age of 74.

T. S. PERKINS died in the Presbyterian Hospital of Irwin, Pa., on January 7, 1940. Mr. Perkins had been in retirement since 1933 when he had held the position of general manager of merchandising engineering of the Westinghouse Electric & Mfg. Co.

CARL W. WIGGINS, chief engineer of the San Diego Consolidated Gas & Electric Co., died of a heart attack on Jan. 16. At the time of his death he was 68 yr. old and had been in the employ of the company more than 46 yr.

Arthur H. Markwart

ARTHUR H. MARKWART, for almost 40 yr. closely identified with Pacific Coast engineering, died at his home in Piedmont, Cal., on Jan. 25. In 1920 he was appointed director of engineering for the

Arthur H. Markwart

purpose of organizing the engineering department of the Pacific Gas & Electric Co. and two years later was elected vice president in charge of engineering, a position he held at the time of his death.

He graduated from the University of California in 1903 and joined the California Gas & Electric Co., a predecessor of the P. G. & E. in 1904. Two years later he became chief engineer and manager of the Syndicate Water of Oakland, vice president and general manager of the Richmond Water Company and later junior member of Howard & Galloway, architects and engineers. As a member of Galloway & Markwart he was closely identified with early plans of the Panama Pacific Exposition in 1912 and acted as assistant director of works and chief of construction. In the world war years he was identified with shipbuilding on the coast.

G. F. Elliott

G. F. Elliott, Chairman of the Board of Elliott Co., died of pneumonia on January 22, following a two weeks' illness. Born in Chicago, July 14, 1893, he was taken to Pittsburgh by his parents shortly afterwards. He went to college at both Cornell and Penn State, graduating from the latter in 1916. He was the oldest son of W. S. Elliott, founder of Elliott Co. and worked in the shops during the summer months of high school and college years.

G. F. Elliott

After graduating from college, the World War having intervened, he spent some time in the Army Ordnance Department. After leaving the army he joined Elliott Co. and started working his way upward. In 1926 when Elliott Co. took over the Ridgway Dynamo & Engine Co., he was made a vice-president of the company, and named manager of the Ridgway Works. Upon the death of W. S. Elliott in 1935 he became president of Elliott Co. and then Chairman of the Board in 1937. He is survived by his widow and five children.

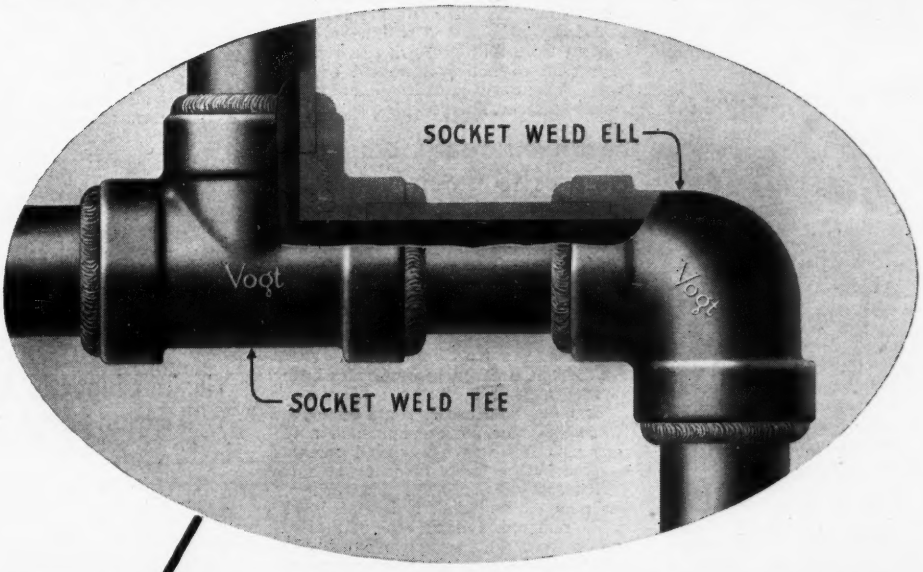
John J. Fasmer

JOHN J. FASMER, General Sales Manager of the Stephens-Adamson Mfg. Co., died suddenly on February 3 at the age of 56 yr. He was connected with this company since it was organized in 1901. He held the position of superintendent of the main factory at Aurora until 1919 when he became manager of the St. Louis sales-engineering office. He worked there until 1931 when he was made General Sales Manager.

John J. Fasmer

now!

DROP FORGED STEEL



SOCKET WELD FITTINGS

by Vogt

Easy to weld.. Stronger.. Safer

That same "drop-forge" quality, heretofore obtainable only in Vogt screwed fittings, is now available in Vogt Socket Weld Fittings. The material in these fittings is uniform in structure, fine grained and free from porosity. Because of the similarity of materials in fittings and pipe, it is easy to obtain sound welds.

Vogt Socket Weld Fittings offer these distinctive advantages;

1. Socket for pipe assures positive alignment before and after welding.
2. No weld "icicles" can clog pipe interiors.
3. Bore of fittings matches I. D. of pipe.
4. Extra margin of strength and safety because they are DROP FORGED BY VOGT.

Available from stock in a full range of sizes.

HENRY VOGT MACHINE CO., *Incorporated* LOUISVILLE, KY.

NEW YORK • CHICAGO • CLEVELAND • DALLAS • PHILADELPHIA • KANSAS CITY

New Construction

J. E. SIRRINE & Co., Greenville, S. C., consulting and designing engineers, have let three special contracts for the new 480-loom rayon weaving plant of the Carter Fabrics Corp., South Boston, Va., one to Adams Electric Co. of Reidsville, N. C., for the installation of the lighting and power wiring; one to Grinnell Co. for outside fire protection and sprinkled equipment; and the other to C. M. Guest & Sons, Anderson, S. C., for the steam piping contract. In addition, the engineers have placed orders for two boilers for the new plant from the Kewanee Boiler Co. and stokers from the Detroit Stoker Company, Monroe, Mich.

CONTRACT has just been awarded to H. R. Beebe, Inc., Utica, N. Y. for the construction of a new boiler plant for The Utica Willowvale Bleaching Co. The building will be 45 ft. by 70 ft., one story, brick, steel and concrete construction. Three, 400 h.p., boilers with auxiliary equipment will be installed. Boilers furnished by E. Keeler Co., Williamsport, Pa. Plans prepared by Lockwood Greene Engineers, Inc., who will supervise construction.

ISSUE OF LICENSE has been ordered by Federal Power Commission to Montana Power Co. for operation of the power development, made by Anaconda Copper Mining Co. in 1926 and acquired by the Montana Co. in 1937, on Flint Creek in the Deerlodge National Forest. The plant has installed capacity of 1500 h.p.

CAPACITY of the Duke Power Co.'s Buck steam station on the Yadkin River near Salisbury, N. C., will be increased by 80,000 kw. with the installation of a G-E hydrogen-cooled 825 lb., 900 F., 1800 r.p.m. turbine-generator, the largest on the Duke Power System. The present 70,000-kw. generating capacity of Buck station is made up of two 35,000-kw. G-E units, installed in 1926. At Duke Power's Cliffside station two other G-E units will go into service early this summer.

CONSTRUCTION of a 25,000 kilowatt capacity addition to the Canal Station of Louisville Gas & Electric Co. at Louisville, Ky., has been authorized by the board of directors of the company, according to T. B. Wilson, president. The new addition will be designed by Public Utility Engineering & Service Corp. and will bring the total tentative construction budget of S. G. & E. system for 1940 to a figure in excess of $40,000,000 involving some 160,000 kw. or additional capacity.

Parker Dam Generators Ordered

GENERATORS for the initial installation of power equipment in the Parker Dam power plant were ordered February 14 by the U. S. Bureau of Reclamation. The Westinghouse Electric and Manufacturing Co. of Denver, Colorado, will furnish three 30,000-kv-a. generators for $1,088,330. The generators are for Units 1, 2, and 3, which comprise the initial installation. Three 40,000-hp. turbines and three governors for these units have been ordered under another contract. Parker Dam power plant is being constructed to house ultimately four main generating units, each with a capacity of 30,000 kw.

Parker Dam, 155 miles downstream from Boulder Dam on the Colorado River, was built by the Bureau of Reclamation for the Metropolitan Water District of Southern California for diverting water into the Colorado River Aqueduct. Although constructed primarily for the purpose of supplying Los Angeles and 12 other cities in Southern California with water, Parker Dam will serve also to generate electric energy for the District and for irrigation pumping requirements.

Under the award the contractor is required to deliver the first generator within 360 days, the second within 420 days, and the third within 480 days after date of receipt of notice of award of contract. The Bureau of Reclamation will install the machinery.

Eastman Kodak Company Returns to Coal Fuel for Power Plant

THE EASTMAN KODAK CO., Kodak Park, Rochester, N. Y., has abandoned the use of natural gas for fuel for power plant at local camera and film-manufacturing works, and has returned to the use of coal. Three years ago the company entered into contract with the Cabot Gas Co., Boston, Mass., which operates in the Pennsylvania and Northern New York natural gas field areas, for a supply of natural gas for power plant, and a 92-mile pipe line was constructed for this purpose by the Cabot company at a reported cost of $2,000,000. This contract has now expired and, it is stated, will not be renewed. Last fall the natural gas supply from the Pennsylvania fields began to diminish to the point where the Eastman company found it necessary to supplement the quantity secured with coal, and gradually has converted the power station equipment until it is now a complete coal-fired unit. The plant is said to use on an average of about 3000 tons of coal per week.

Pacific Power & Light Authorizes Fund of $1,050,000 for 1940

PACIFIC POWER & LIGHT CO., Portland, Ore., has authorized an appropriation of $1,050,000 for expansion and improvements in plants and system during the present year, of which approximately $400,000 will be used for power plants, power substations and allied structures, including installation of additional equipment; and $600,000 for extensions in transmission and distributing lines, with a portion of fund for rural electric systems and service facilities. Company is now furnishing service to a total of 130 cities, towns and communities in Oregon and Washington.

United Light & Power Plans $17,245,900 Construction Budget in 1940

THE UNITED LIGHT & POWER CO., Chicago, Ill., is arranging an appropriation of $17,245,900 for expansion and betterments in properties throughout the country during 1940, of which approximately $11,200,000 will be used for electric plants and systems; $5,000,000 for development and betterments in gas properties; and remainder for other utilities, including ice and refrigerating plants; waterworks and systems; central steam-heating systems; and transportation properties. For its various electric utilities, it is planned to carry out expansion in generating stations, power substations and switching stations, transmission and distributing lines, rural electric systems and other facilities, with a considerable part of miscellaneous work to cover service extensions for a large group of new consumers.

Virginia Electric & Power Will Expend $3,676,400 in 1940

THE VIRGINIA ELECTRIC & POWER CO., Richmond, Va., is arranging a fund of about $3,676,400 for expansion and improvements in plants and system during 1940, including installation of equipment and facilities for considerable increased capacity. Of the amount noted, close to $1,000,000 will be used for completion of work now in progress, consisting of a new addition to local steam-electric generating plant on Twelfth Street, as well as new hydroelectric power station on the St. James River, vicinity of the Kanawha Canal. Approximately $500,000 will be expended for transformers and accessories, meter equipment, etc., and about $540,000 for transmission and distributing line extensions, of which close to $100,000 will be used for rural electrification. At Norfolk, Va., company will make extensions and improvements in gas pipe lines and station facilities to cost about $125,000.

Manufacturers' News

W. J. VOGEL has been appointed Assistant Chief Engineer of Combustion Engineering Co., Inc. He entered the employ of Combustion Engineering Co. in 1924 as a contract engineer. Since then he has spent four years in engineering sales work in the Philadelphia and Detroit offices of the company and most of the remaining time as a contract engineer in the Engineering Department.

M. H. KUHL has been appointed Assistant Manager of the Industrial Division of The Timken Roller Bearing Co, succeeding S. D. Partridge, who was made Manager of the Industrial Division.

L. G. BRIGGS, manager, Chicago retail branch, of Fairbanks-Morse, was re-elected president of the Midwest Stoker Association at its tenth annual meeting held at the Stevens Hotel, in Chicago, January 19th. E. M. May, manager of Combustioneer's Chicago retail branch was re-elected Vice President and E. W. Jones, office manager, Chicago branch, Iron Fireman Mfg. Co., was elected Secretary-Treasurer. These three officers together with Mount Burns, manager, Chicago retail division, Link-Belt Co., and E. H. Markland, Chicago Division manager, Whiting Corp., make up the new Executive Committee of the Association.

POWELL BRONZE VALVES

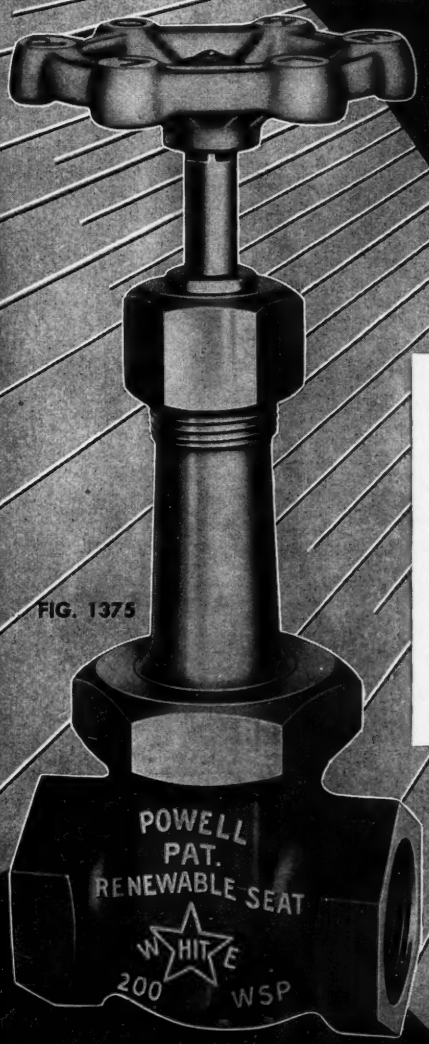


FIG. 1375

It's a serious matter, both costly and annoying, when a busy plant has to shut down for valve repairs . . . That's why it pays to use Powell service-tested valves for steam, water, air, gas, and oil lines . . . The seats and discs can be renewed—the valves repacked under pressure without disconnecting them from the pipe line . . . On your next order specify POWELL

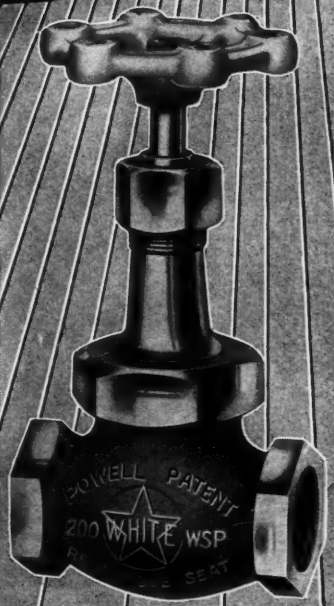


FIG. 1708

FIG. 99

POWELL VALVES

THE WM. POWELL CO. CINCINNATI, OHIO

V. H. PETERSON, who for the past two years has been Assistant to the President in co-ordinating sales activities, has been named General Sales Manager of the Elliott Co., effective January 1. Mr. Peterson joined the Elliott Co. in 1925 from Rensselaer Polytechnic Institute. He was sales engineer in the Pittsburgh office and district manager of the Rochester and Washington, D. C. offices, before returning to Jeannette in 1938.

J. M. COSGROVE has recently been appointed Director of the Development Laboratory of the Standard Steel Spring Co., Coreopolis, Pa., according to an announcement by R. C. Enos, President. Mr. Cosgrove is an electrochemical engineer and has been associated with the Noblitt Sparks Industries, the Meaker Co. and the Western Electric Co. since his graduation from the Massachusetts Institute of Technology. He expects to be actively engaged in research work on corrosion proof coating.

CHARLES E. WILSON, Vice President since 1934, in charge of the Pacific Coast Operations to the Worthington Pump and Machinery Corporation, is moving his headquarters to the home office of the Corporation at Harrison, New Jersey, where he will direct the sales of all products handled by the Corporation's Carbondale Division, which specializes in air conditioning and refrigeration equipment. In this work Mr. Wilson succeeds H. A. Feldbush who henceforth will devote his time to the manufacturing department of the Corporation. Mr. Wilson is also assuming directional charge of the sales of all Corporation's products built at the Holyoke, Massachusetts, factory, consisting of small stationary compressors, portable air compressors, rock drills, contractor tools and turbine well pumps.

J. E. BEGERT, manager of the local Johns-Manville factory, announces the following promotions: George S. Smith of LaGrange, Indiana, who has been plant engineer since November 1, 1932, has been made Assistant Chief Engineer of the Johns-Manville, General Engineering Department. E. I. Merrell of Edgemont Key, Florida, Mr. Smith's former assistant at the Manville J-M Factory, will succeed him as plant engineer in the Manville factory.

EDGE MOOR IRON WORKS, INC., announces the appointment of D. H. Sheen & Co., 1 No. La Salle St., Chicago, Ill., as exclusive sales agents in Chicago territory for Edge Moor Boilers and appurtenances.

E. C. MARHAN, who has been president of Southern Coal & Coke Co. for 22 yr., has been promoted to the position of chairman of the board of directors, a newly created post. W. A. Ellison, formerly vice president, has been promoted to president to succeed Mr. Mahan.

W. A. ELLIOTT, for the past two years Cincinnati District Manager of the Elliott Co., has been appointed Chicago District Manager. Mr. Elliott had had sales experience in the Atlanta, Chicago, New York and Pittsburgh District Offices before going to Cincinnati. E. H. Haslam, who has served for 12 years as Chicago District Manager, requested that he be relieved of the management responsibilities of the office, and remains in the Chicago Office staff as a special representative.

THE JOHNSTON & JENNINGS CO., Cleveland, Ohio, announces the appointment of Robert H. Emerick as Assistant Sales Manager of their Stowe Stoker Division. He comes to Johnston & Jennings directly from the Henry Vogt Machine Co. where he has been in charge of boiler sales in the New York and New England territories.

ACCORDING to an announcement by Robert C. Stanley, Chairman and President, H. R. MacMillan has been elected a director of The International Nickel Co., of Canada, Ltd. He fills the vacancy caused by the death of James A. Richardson of Winnipeg, Manitoba, and his election will provide the board with representation from Western Canada.

TIDE WATER ASSOCIATED OIL CO. has set up a Southern branch office for distribution of its products. The new office and warehouse are located at 1122 South Boulevard, Charlotte, N. C. R. H. Mariner is the new regional manager, and W. H. Young, Jr., will assist him in a sales capacity.

Moore Becomes Division of Worthington

THE WORTHINGTON PUMP AND MACHINERY CORP. announces that, since January 2, 1940, its subsidiary, the Moore Steam Turbine Corp., of Wellsville, New York, has been conducted as the Moore Steam Turbine Division of the corporation.

Moore Steam Turbine Corp. was a wholly owned subsidiary of the Worthington Pump and Machinery Corp. for three years, during which the corporation's nation wide sales organization with its service facilities has increased the volume of steam turbine sales to a point where it has been necessary for the corporation to provide additional plant capacity. A new manufacturing building and new equipment are about ready for use.

The larger field of operations made possible by affiliation with Worthington has materially added to the number of employees at the Wellsville plant and increased the value of the industry to the community.

For the Engineer's Library

Recent bulletins and catalogs on power plant equipment listed for your convenience in securing specific information. Power Plant Engineering will be glad to procure for you any free literature that you desire.

Valves and Piping

Joint Sealing Compound—A bulletin just issued calls attention to Seal-Rite joint sealing compounds for piping and industrial equipment. Two types are described. No. 5 for pipe lines and equipment carrying high pressure steam, gases, oil, gasoline, grease and solvents. No. 10 for hot and cold water low pressure steam, compressed air, alcohol and brine. Macksons Co.

Gate Valve—This new 8 page circular No. 504-RL shows the complete line of Lunkenheimer "King-clip" Valves with drain channels and bronze thread bushing in bonnet. The Lunkenheimer Co.

Welding—A valuable guide to welding commonly used metals and alloys has recently been printed in chart form 4464. Recommended welding method, flame adjustment, welding rod, and flux for each of the 30 different metals and alloys can be determined at a glance by referring to this handy outline. The Linde Air Products Co., a Unit of Union Carbide and Carbon Corp.

Hose—A new 32-p. booklet has been prepared to assist the prospective buyers and present users of hose in making the proper selection of hose that will best fit his purpose. United States Rubber Co.

Pipe Tools—A new 24-p. catalog gives a description of the complete line of Beaver pipe tools. The newly developed No. 71 Pipe and Bolt Threader is completely illustrated and described. Beaver Pipe Tools, Inc.

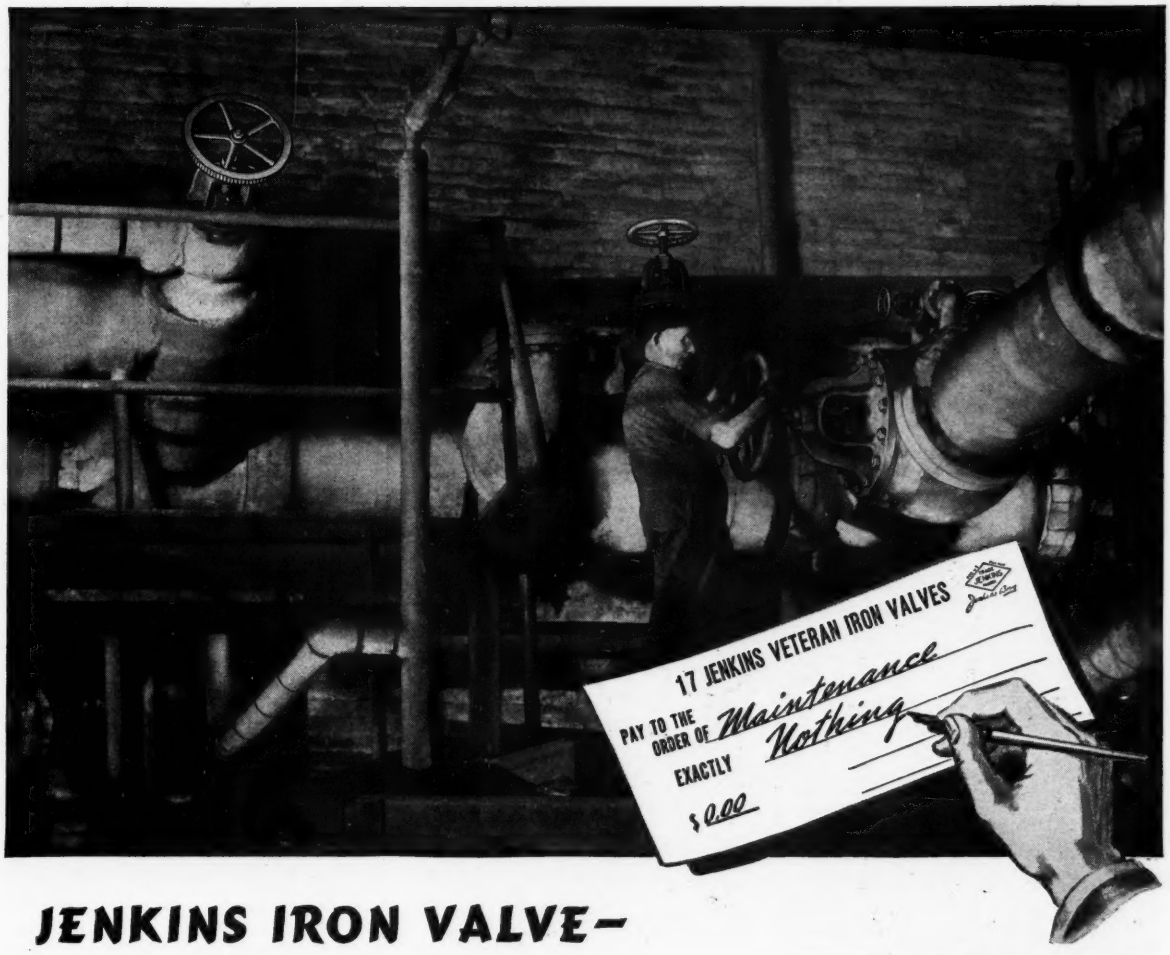
Master Pilot Valve is described in a 2-pp. illustrated leaflet No. 2279 which has just been issued by The Permutit Co.

Valves—Bulletin 301-B-2 gives a description of several newly developed back pressure valves. Applications, construction and dimensions are covered. Connelly Iron Sponge and Governor Co.

Welded Fitting—A new booklet, Anaconda Publication E-9, describes in detail a new line of large size welded fittings and gives roughing-in dimensions and list prices. The American Brass Co.

Valve—A 30-page data book entitled Jenkins Recommends will be helpful when specifying valves for use in connection with boilers, engines, turbines, Diesels, pumps and heaters. Pipe lines diagrams indicate valve positions. Jenkins Bros.

Expansion Joint—A revised, 8-pp. illustrated Bulletin No. 35-20A on the ADSCO Internally-Externally Guided Expansion Joint in sizes from 1¼ to 20 in. gives specifications, dimensions, weights and list prices. American District Steam Co.



JENKINS IRON VALVE— WRITES A CHECK . . .

WHY do we send a photographer to peer up at these Jenkins Valves installed in the boiler room at Todd Co.'s plant, Rochester, N.Y.

First, because they're real veterans—installed in 1902. Second, they have a history of low-cost, trouble-free performance to make any engineer proud.

Let us take that big valve as an example. It's a 14 inch Jenkins Extra Heavy Iron Body Globe Valve with steam metal disc. Main header is under constant pressure of 125 lb. steam. Yet, Chief Engineer George Fisher, recently retired, verifies the fact that this valve cost them *nothing* in maintenance from the day it was installed.

This is but one of thousands of certified case histories where Jenkins Iron Valves have proved sound dollars-and-cents investments. No wonder, men who buy valves on a cost-per-year basis, specify Jenkins.

JENKINS BROS., 80 White St., New York, N.Y.; Bridgeport, Conn.; Boston; Atlanta, Ga.; Philadelphia, Pa.; Chicago, Ill.; Houston, Texas Montreal, Canada London, England

TRY THE COST-PER-YEAR TEST

on these Jenkins Iron Valves

Initial Cost *(17 valves)* . $1307.20

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Maintenance 0.00

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Years of Service 38

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Cost-per-year (per valve) . . *$2.03*

and they're still going strong!

IN VALVES *Jenkins* GIVES YOU EVERYTHING

Everything has been narrowed down to its simplest form. All the material about any given packing is grouped on one page — service qualifications are clearly indicated — unique layout arrangement instantly spotlights packing construction.

There are other features too in this latest Belmont Catalog. Send for your copy today. It's an invaluable reference book wherever packings are used.

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PACKINGS

THE BELMONT PACKING & RUBBER COMPANY

BUTLER AND SEPVIVA STREETS • PHILADELPHIA, PA.

Pump and Compressors

Pump Selection Tables—Complete selection tables, typical specifications, principal dimensions and other engineering information have been included in a number of pump bulletins. The data given in these bulletins permits the engineer to outline preliminary plans, make tentative selection and write specifications. Recent bulletins prepared in this manner are: Builtogether pumps, Bulletin 5550C; Single stage split case centrifugal pumps, 5810D and 5874A; Side suction centrifugal pumps, Bulletin 5520P; Two-stage centrifugal pumps, Bulletin 5972; Sewage and trash pumps, Bulletin 5410C, and Close coupled sewage and trash, Bulletin 5430. Fairbanks, Morse & Co.

Compressor — Worthington Type LTC angle gas engine compressors are described in Bulletin L-600-B10. Catalog H-620-B18E gives detailed descriptions of the complete line of Worthington air compressors. Worthington Pump and Machinery Corp.

Pumps—A new bulletin No. 142 entitled Pumps By Smith gives a complete description of the Axial Flow Pump with automatically adjustable blade impeller. S. Morgan Smith. Co.

Miscellaneous

Bearing — A booklet describing Fast's Multiple Oil Film Bearing outlines the history of bearings, discusses the principle of Fast's bearing, describes and illustrates its design, provides tables of dimensions and load capacities, dimensions of standard bearing housings, recommended shaft sizes, dimensions of lock nuts and proper oil levels. Coppers Co., Bartlett Hayward Division.

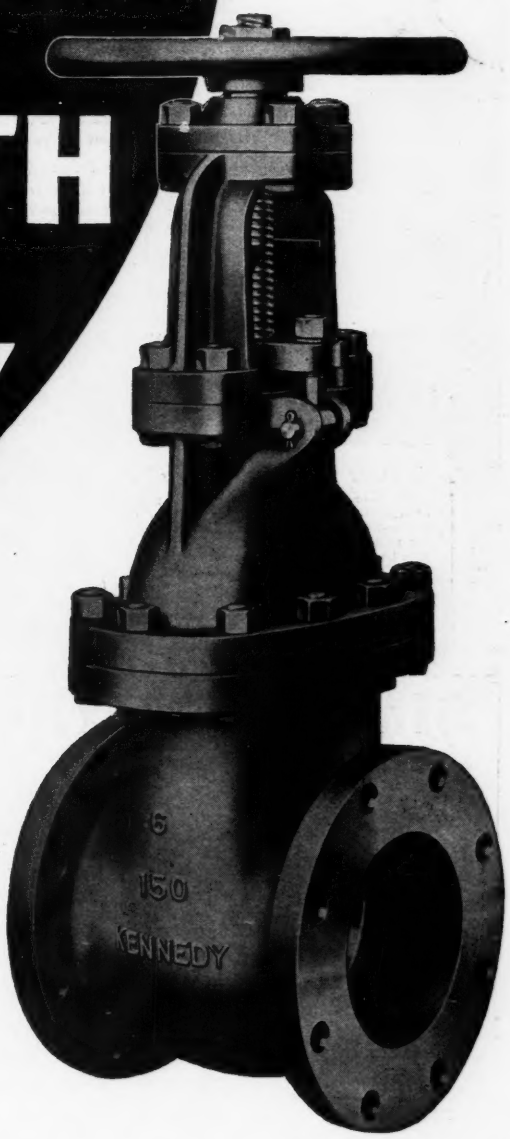
Packing—Catalog No. 10 entitled Asbestos and Rubber Packings, illustrates and describes those packings in general use. Recommendations are listed to help in making selection of the proper packing for any particular requirement. The Darcoid Co.

Conveyor—Catalog 730 containing 12 pages gives a complete description of the Mass-Flo conveyor. Construction, applications, sizes and capacities are included. The Jeffrey Mfg. Co.

Engineering Aids—Prepared in the form of a handy-sized 32-page book, the complete 1940 directory lists in numerical order more than 350 separate bulletins and other engineering aids now available from the factory on request. These include 280 different items of power, electrical and industrial machines produced by the company; about 40 instruction books and repair part bulletins, and 38 catalogs and folders on tractors, farm equipment and road machinery. It also lists 1610 different and widely diversified products. Allis-Chalmers Co.

Conveyors — An informative four-page Folder No. 1804 describes bronze drive and conveyor chains for resisting the destructive effect of organic and inorganic acids. Link-Belt Co.

EXTRA MARGINS OF STRENGTH AND QUALITY



Throughout this Kennedy Standard Wedge Gate Valve you will find extra values—at no extra cost—that make it thoroughly dependable, easy to operate, and long lived.

Some of these extra values are metal 50% stronger than ordinary cast iron, bronze bushings at all stem contact surfaces, better support of stem at yoke nut, provision for longer service from seat rings, and special conveniences for repacking.

There are 33 notable features of these Kennedy Valves —described in bulletin which every valve user should have. Your copy will be sent on request.

The Kennedy Valve Mfg. Co., Elmira, N. Y.

KENNEDY

STANDARD IRON-BODY *Wedge* GATE VALVES

Now we'll turn it . . . SAFELY!

Here's unstoppable power when you "put your back into it"—but *safe* power—because you get full leverage with only 20° handle movement—and the socket locks on the ratchet, clings to the nut 'til you're through.

Selected tools for hand operations are as important in plant safety as special controls for machinery. Make sure the hand tools used for maintenance and production in *your* plant are *safety* designed. Snap-on tools *are*—and there are 2300 of them from which to choose.

Complete information about Snap-on tool service gladly sent on request—write

SNAP-ON TOOLS CORPORATION
Dept. PPE-3 Kenosha, Wisconsin

L-1800 Extra Heavy Duty Set

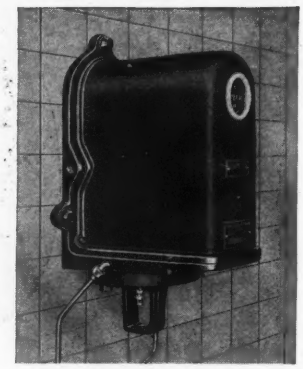
64 wrench combinations, covering most of the large-nut turning operations, can be quickly assembled from this Snap-on set that includes 30" sliding bar, 2 extension bars and 18 powerful hexagon sockets from 1½" to 2⅝".

The *complete* Snap-on Extra-heavy duty line includes 75 hexagon sockets from 1 7/16" to 4⅝" and a wide range of handle equipment.

Snap-on Wrenches
The Best Tools are the Safest Tools

SIMPLEX GYROMETER

An Inexpensive New Flow Meter For ALL Fluids



IN balancing a differential head applied to a diaphragm unit by means of gyroscopic couple forces, the Simplex Gyrometer insures accurate, straight-line totalization of any fluid flow.

The Simplex Gyrometer can be used with any type of primary pressure reducing device (orifice, venturi tube, nozzle, pitot) in any size of main to measure fluids varying from water and air to steam, gases and corrosive liquors.

Let us show you how this inexpensive and reliable unit will help you in solving your metering problems.

WRITE for FREE BULLETIN

SIMPLEX VALVE & METER CO.
6790 Upland St., Philadelphia, Pa.

Instruments—A new calendar for 1940 pictures varied problems of boiler room operation in a humorous vein by a series of original cartoons. Helpful engineering information is presented in the form of feedwater and saturated steam temperature tables an evaporation chart, a per cent CO_2 chart, and several steam and water flow capacity tables. The Brown Instrument Co.

Light for Work is the title of a new book describing Acme Mercury Vapor Transformers for indoor and outdoor applications. It also explains concisely the characteristics of mercury vapor lighting, the various types of lighting systems for specific and general applications. The Acme Electric & Mfg. Co.

Heater—New and improved electric heating units and controls, designed to meet specific industrial applications for heating liquids, solids, and air are announced in a new 38 page illustrated catalog. Westinghouse Electric & Mfg. Co.

Electrical Equipment—Bulletin GB-234 gives a complete description of Burlington automatic generator voltage regulators, including construction, operation and application. The Burlington automatic synchronizer is completely described in Bulletin SN-1. Burlington Instrument Co.

Steam Turbine-Generators is the title of Bulletin H-10 a 32-pp. catalog in color showing typical installations, describing the type and construction of different turbines and turbine generator units, their construction and arrangement with 2 full page charts for calculating the water rate for condensing and non-condensing units. Elliott Co.

Water Treatment—The Filtrex system of water treatment is briefly discussed in a new bulletin. Filtrex Co.

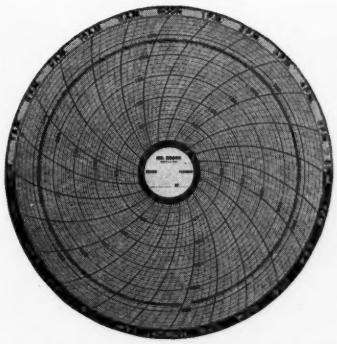
Steam Jet Ejector—Bulletin W-205-B7 gives complete description of Worthington steam-jet ejectors of the two-stage condensing type. General description, specifications and engineering data are included in the bulletin. Worthington Pump and Machinery Corp.

Oil Burners—A new 4 page folder illustrates and describes Enco fuel oil pumping and heating systems. Specifications for Enco oil pumping and heating units for heavy oil service are included in the folder. The Engineer Co.

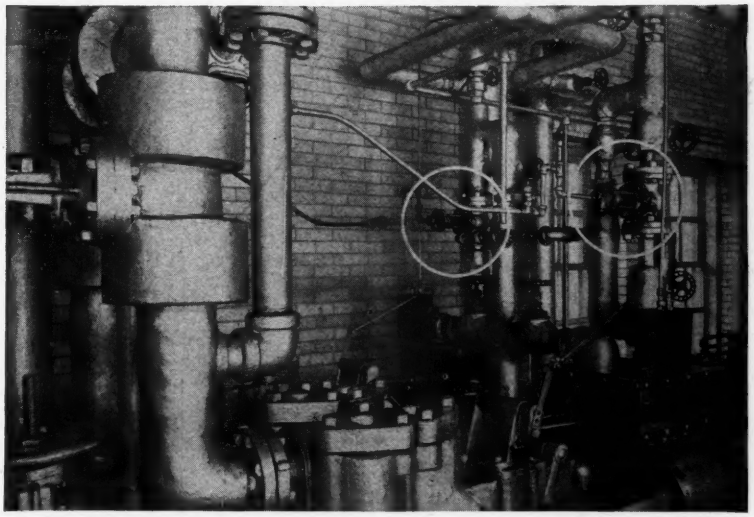
Elesco Superheaters is the title of a 24-page catalog covering details of construction of both the ball-joint and the welded types. Numerous diagrams show various arrangements for application to different types of boilers and to meet different conditions. Control of superheat by means of bypass dampers is explained. Combustion Engineering Co., Inc.

Where even seconds "out of service" count...

these FOSTER PUMP GOVERNORS *haven't missed a beat in 70,000 hours of continuous operation*



This twenty-four hour record of fuel oil pressures in a New York Hospital attests to the accuracy of regulation of the two Foster Type 38-P6 Pump Governors controlling the pumps. This chart shows no fluctuations in pressure, and is typical of the performance enjoyed, day after day, by the many users of these governors.



Send for this new catalog!

This twenty page fully-illustrated catalog, containing practical and useful information (application, features, operation, installation — even dimensions and weights) on the complete line of Foster Pump Governors will soon be off the press. A copy will be sent to you without obligation or cost . . . simply ask for Catalog 70, Bulletin 13.

That Foster Pump Governors are *accurate* as well as *dependable* and *durable* is evidenced by the accompanying chart and the following report from the Chief Engineer* of a New York Hospital.

> "The enclosed chart covers twenty-four hours operation of our fuel oil pumps, which are controlled by Foster Pump Governors.
>
> "We installed these governors in 1932, and immediately noticed an increase in over-all boiler efficiency due to improved combustion resulting from constant fuel oil pressure.
>
> "In addition to accuracy of regulation, I think you are to be complimented on the ruggedness of these valves.
>
> "With the exception of substituting stainless steel main and auxiliary valve seats and stems for the original bronze construction, not one part of either governor has been repaired or replaced during some 70,000 hours of continuous operation."

Whatever your regulation or control problem, if you are interested in accurate and dependable operation with lowest costs for maintenance, investigate Foster — *first*.

*Name on request.

FOSTER ENGINEERING Company

PRESSURE REGULATORS • RELIEF AND BACK PRESSURE VALVES • AUTOMATIC STOP AND CHECK VALVES • ALTITUDE VALVES • DAMPER REGULATORS • FAN ENGINE REGULATORS PUMP GOVERNORS • TEMPERATURE REGULATORS • LIQUID LEVEL CONTROLLERS • FLOAT AND LEVER BALANCED VALVES • NON-RETURN AND TRIPLE DUTY VALVES • VACUUM REGULATORS OR BREAKERS • SIGHT FLOW BOXES • STRAINERS • SAFETY VALVES

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IN

DART UNIONS

...means

Better Service

The large area of *seating contact* is an outstanding reason why Dart Unions give you more for your money. But Dart seats are not only extra wide: they are *accurately ground* over their full width for "full bearing" contact. They come apart easily, remake readily—give you leak-proof joints once, twice, again and again, cut your *cost-per-tight-joint* to rock bottom. . . . Dart bronze alloy seats have high resistance to corrosion. Bodies and nuts of air-refined malleable iron withstand wrench abuse. . . . Write for a Dart to try, free.

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Sales Agents: The Fairbanks Company, New York, and all branches

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Power Papers on A.S.M.E. Spring Meeting Program

AMONG the papers of particular interest to power plant engineers which will be presented at the Spring Meeting of the American Society of Mechanical Engineers, to be held at Worcester, Mass., May 1 to 3, are:

Feedwater Treatment, C. H. Fellows, The Detroit Edison Co., Detroit, Mich.; Industrial Steam Power, W. F. Ryan, Stone & Webster Engineering Corp., Boston, Mass.; Burning of Heavy Fuel Oil, G. C. Martinson, Fuel Engr., Sinclair Ref. Co., Marcus Hook, Pa.; Purchase and Use of Fuels, E. Wadsworth Stone, Cons. Engr., Bigelow-Sanford Carpet Co., Inc., Thompsonville, Conn.; Effect of Coal Characteristics on Pulverized Coal Firing, Ollison Craig, Engrg. Mgr., Riley Stoker Corp., Worcester, Mass.; Recent Developments of Oil Burners, R. C. Vroom, Ch. Engr., Peabody Engineering Corp., New York; Determination of the Purity of Steam, M. C. Schwartz, Res. Chemist, W. B. Gurney, Efficiency Engr., and Thomas E. Crossan, Supt., Gulf States Utilities Co., Baton-Rouge, La.; Low Velocity Characteristics of the Salt Velocity Method, L. J. Hooper, Asst. Prof. of Hydr., Worcester Poly. Inst., Worcester, Mass.; Comparative Tests of Flow Measurements, O. H. Dodkin, Brazil, S. A.; Thermodynamic Properties of Vapors, Eric Leib, Combustion Engineering Co., New York; The New Specific Heats, R. C. H. Heck, Res. Prof. M. E., Rutgers Univ., New Brunswick, N. J.; Progress Report on Cavitation Testing of Materials, B. G. Rightmire, Instr. in M. E., Mass. Inst. of Tech., Cambridge, Mass.; Cavitation Tests of Hydraulic Turbines, R. E. B. Sharp, Chief Engr., I. P. Morris Dept., Baldwin-Southwark Div., Baldwin Locomotive Wks., Philadelphia, Pa.

Professor Charles M. Allen of Worcester Polytechnic Institute is Chairman of the General Committee on arrangements.

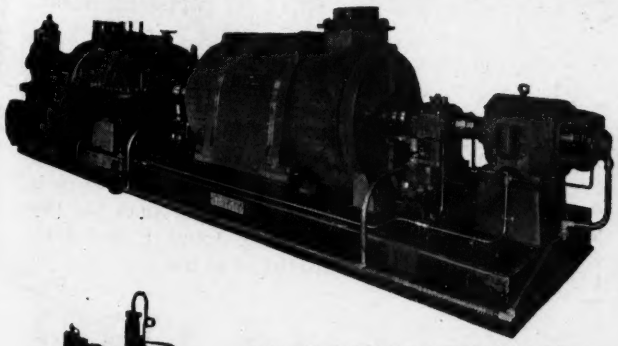
Nickel Alloys for Electrical Equipment

ALLOY cast irons of most interest in connection with the electrical equipment generally found in power stations are those which by virtue of their high alloy content are non-magnetic. Incidentally these irons, according to the Internation Nickel Co., also possess a high degree of electrical resistance which explains their superiority over brass and other non-ferrous alloys when non-magnetic parts are required, and in which high resistance assists further in reducing eddy current effects and electrical losses.

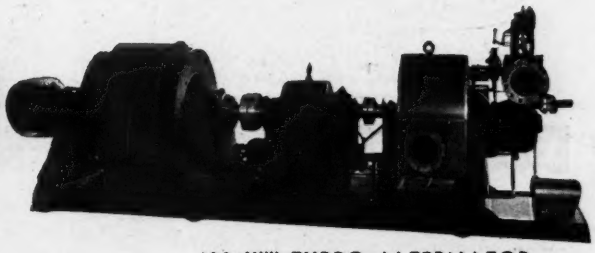
The first non-magnetic cast iron developed for this type of work was that known as "Nomag" which

(Continued on Page 116)

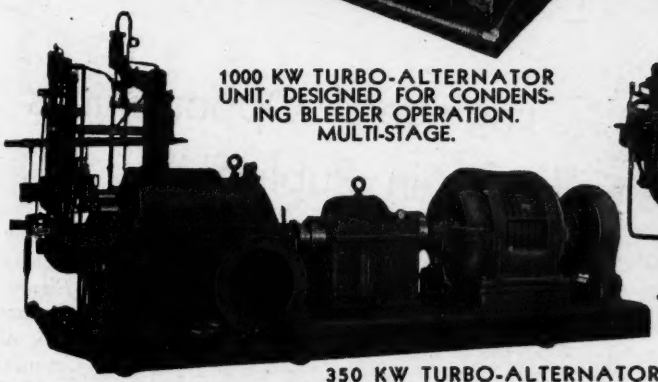
TERRY



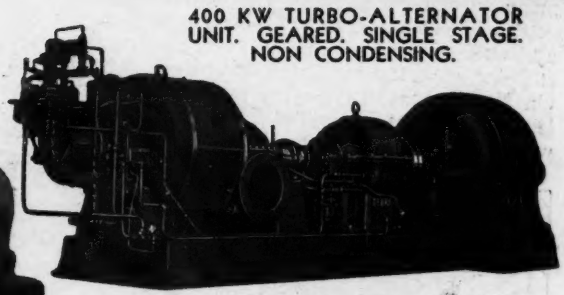
1000 KW TURBO-ALTERNATOR UNIT. DESIGNED FOR CONDENSING BLEEDER OPERATION. MULTI-STAGE.



400 KW TURBO-ALTERNATOR UNIT. GEARED. SINGLE STAGE. NON CONDENSING.



350 KW TURBO-ALTERNATOR UNIT. GEARED. MULTI-STAGE. DESIGNED FOR MIXED PRESSURE BLEEDER OPERATION.



500 KW TURBO-ALTERNATOR UNIT. GEARED. MULTI-STAGE. NON CONDENSING.

For Turbo-Generator Units

Terry Generator Units are individually designed and proportioned so as to operate most efficiently under the customer's conditions. They are the result of over 40 years of successful experience in the manufacture of steam turbines.

They are available in high, low, mixed and bleeder designs in all capacities up to 1000 KW.

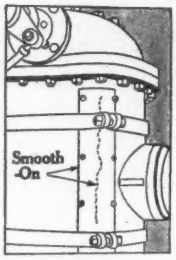
THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

T-1136

Costs less than a lottery ticket

But ALWAYS PAYS OUT!

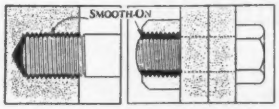
Fifty cents' worth of Smooth-On No. 1 has made many an emergency repair that saved over $100.00 in getting idle men and machines back to work sooner after a breakdown—and even in such everyday repair work as stopping small leaks and tightening loose parts, Smooth-On No. 1 *always* pays a *big* return in saving of time, labor and actual cash. The first application in routine work usually pays for all the Smooth-On No. 1 needed for the next ten, and the annual return effected by Smooth-On in reduced maintenance expense can be far better than that for anything else that you could put into your plant.



Cracked shell repaired with Smooth-On No. 1

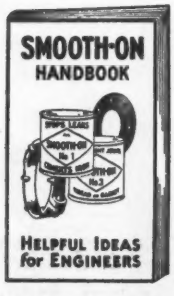
A small supply of Smooth-On No. 1 kept in the store room costs only a few cents, but is a protection you should not overlook. Take this precaution — be prepared — and when your can is empty get another at once as you would renew an insurance policy. Unused Smooth-On does not deteriorate in the original can.

To know how Smooth-On should be used for best results, mail the coupon for a free copy of the Smooth-On Handbook, containing advice, instructions, working diagrams, etc., that every Engineer should have on his desk for quick reference.



Loose bolt and nut tightened with Smooth-On

Buy Smooth-On No. 1 in 1 or 5-lb. can or 25 or 100-lb. keg from your supply house or if necessary from us. For your protection, insist on Smooth-On—used by engineers and mechanics since 1895.



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Please send SMOOTH-ON HANDBOOK.

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***Do it with* SMOOTH-ON**

is a cast iron alloyed with 12 per cent nickel and 6 per cent manganese. This iron has proved successful for castings such as alternator end rings for switch covers and bus bar chambers and for other parts where its non-magnetic quality is of special value. In addition to the advantage of the non-magnetic cast irons in their having a high electrical resistance it should be mentioned that the irons also have a high melting point and are therefore particularly safe when any risk of fire is present, as for example in transformers.

High electrical resistance of these irons has also led to their adoption for resistance grids while in other cases, where the non-magnetic quality is not considered a special advantage, a lower alloy content cast iron containing 3 to 5 per cent nickel is also used for this application, the nickel conferring not only a higher electrical resistance than for the plain cast iron but also being tougher and thus resisting fracture in transport or in use.

Engineers' Opportunities in Public Life

THE MONOPOLY on public life long held by lawyers will soon be broken up, and engineers will advance to first rank in this field, Mark Eisner, member of the New York Bar and former chairman of the Board of Higher Education of the City of New York, predicted in an address at the annual Founder's Day dinner of the Cooper Union Alumni Association February 3.

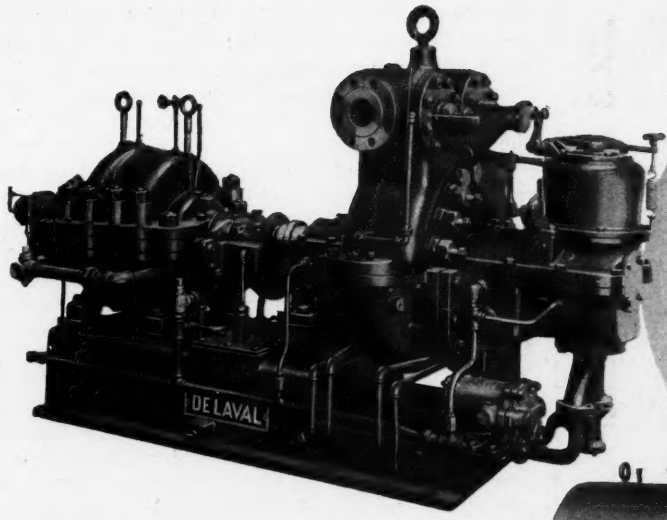
"American public life is overrun with members of the law profession," he said. That nearly all public offices in the land are occupied by men who have had legal training is no mere accident. Those who were fitted for the 'job' of the practice of the law are favorably placed with respect to their participation in public life. Thus public service and public office is the watershed down which the 'lawyer's' life tends to flow.

"At every point in our body politic we find vital changes which are becoming more and more evident, and must soon be recognized by our community. A glib tongue and an attractive personality no longer suffice to qualify one for public service. On the other hand, the speaking and personality techniques may be much more readily acquired by able, energetic and ambitious persons—no matter what their professions may be."

Society is becoming more complex and more dependent on the machine and the produce and supervision of the trained engineer, Mr. Eisner pointed out. "This dependence imposes a public responsibility upon the technically trained person far in excess of the responsibility which rests upon most of the other citizens," he added.

"The engineering profession, a comparatively new profession in American life, has become of primary

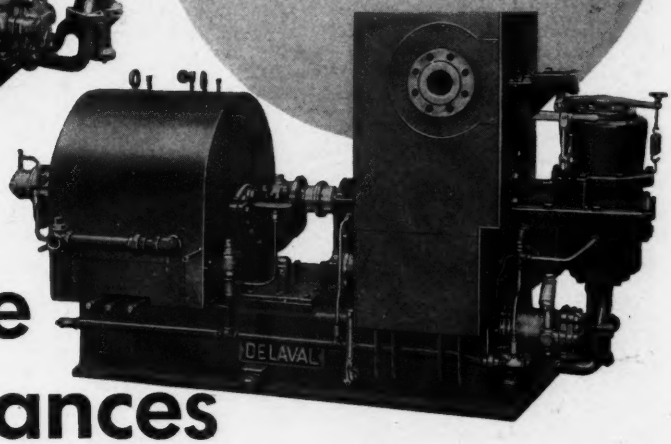
(Continued on Page 118)



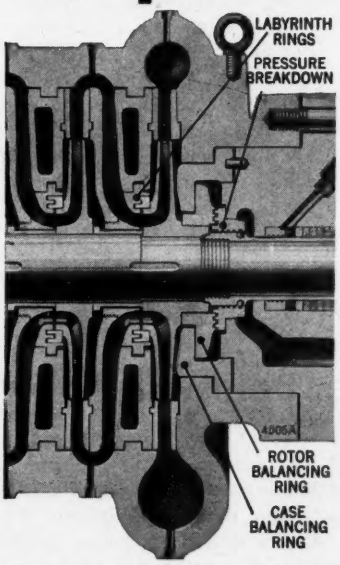
One of 24 three-stage turbine driven boiler feeders for new 18-knot bulk oil tankers; 300 g.p.m. each of 235°F. water against 575 lb. per sq. in. at 4000 r.p.m.

•

The same pump with lagging applied. The turbine and pump casings are of cast steel. The turbine receives steam at 425 lb. gage and 500°F. and exhausts against 10 lb. back pressure to feed heater.



DE LAVAL PUMPS have ample clearances



Section of discharge end of multistage boiler feed pump, showing De Laval Labyrinth Wearing Rings and De Laval Automatic Axial Balancing Device.

A PROMINENT steam engineer states that "there is a tendency on the part of the pump manufacturers to maintain too close clearances on their running parts in order to obtain the last per cent of efficiency. The operator would much rather sacrifice this last bit of efficiency and have what he feels is a more reliable unit that, because of larger clearances, will operate satisfactorily over a wider range of operating conditions".

The De Laval Labyrinth Wearing Rings, insure the reliability demanded by this engineer. They reduce leakage from discharge to suction chamber, make possible larger running clearances without sacrifice of efficiency and are subject to much less wear than are flat rings.

The De Laval Automatic Balancing Arrangement maintains perfect axial balance without dependence upon close radial clearance and holds the rotor in correct position for minimum leakage under all operating conditions.

● *All explained, with diagrams and figures, in our new Multistage Pump Book B-5, sent upon request.*

3613

HYDRAULIC INSTITUTE U.S.A. MEMBER

DE LAVAL *Steam Turbine Co.*
TRENTON, N. J.

MANUFACTURERS OF STEAM TURBINES, PUMPS—CENTRIFUGAL, PROPELLER, ROTARY DISPLACEMENT; CENTRIFUGAL BLOWERS AND COMPRESSORS; WORM GEARS; HELICAL GEARS—HYDRAULIC TURBINES AND FLEXIBLE COUPLINGS • • • SOLE LICENSEE OF THE BAUER WACH EXHAUST TURBINE SYSTEM

QUICK EASY CHANGE to
Better Gage Visibility and Safety with
Reliance Prismatic Inserts

Now you can have sharp, distinct boiler gage readings—avoid the grief and expense that goes with gage glass breakage. Reliance Prismatic Gage Inserts make water appear *black*, steam *white*, give exceptionally high visibility—*mistake proof*.

Reliance Prismatic glasses are made of the best quality American glass, heat-treated for toughness to prevent the shattering that causes injuries. Securely held in strong body by exclusive clamping principle. Styles for any liquid level height.

Check your plant for worrisome gage jobs in steam, oil, water or chemicals. Write today for Bulletin Number 391.

Reliance Prismatic may be used on pressures to 1000 lbs. temperatures to 500° F.—on deaerating heaters, flash tanks, accumulator and similar tanks.

The Reliance Gauge Column Company
5902 Carnegie Ave. • Cleveland, Ohio

Reliance
Boiler Safety Devices since 1884

importance to the economic, social, and physical well being of our country and its people. This is indeed a far cry from the early nineteenth century when pressing engineering problems were solved by handymen and mechanics with a little native ability and the constructive sense.

"The natural ability of the early American engineers could not be doubted, but as artists in a primitive community, their participation in public life necessarily was confined to their limited importance in this community. Now this is all changed, and with this change has come a new order of things in which the engineer is king. It therefore becomes the duty of the engineer to act the role of the king.

"Our modern democracy, operating as it does, in a highly mechanistic society, cannot function efficiently without the contributions of all the elements to the public life of the community. The engineer has come to be a vital part of the community, and perhaps the most vital part. Thus his leadership of our community has been advanced to a point of the utmost importance to the public welfare.

"I cannot think of a single activity in modern life which is independent of the contribution of the engineer. The engineering field has come to be so broad as to include in its beneficial scope the entire public weal. 'The study of the fundamental laws and the application of these along with logical and straight thinking to correct solution of problems' has come to be the utmost need of our society. Who better than the engineer can fulfill this need?

"He has been fulfilling this need in every walk of life, so that no industrial organization in America is complete without a trained engineer in its management or at its head or is without the benefit of engineering counsel. No municipality in America can function without the help of engineers. No advances in our commercial and profession life can be made without the engineer and his special knowledge and leadership. Every phase of human conduct has come to benefit from engineering training and skill."

Stream Flows Are Below Normal

PRECIPITATION during December continued below normal in all regions except the Pacific northwest and Nebraska, according to reports from the U. S. The maximum deficiency during that month occurred in Arizona and Utah, being 29 and 37 per cent respectively of normal. District engineers of the Survey report that some small streams and shallow wells in the Great Plains region have failed as water sources.

Climatic trends during the winter and spring months will be most important in the west central Great Plains region where there occurred the greatest annual deficiency. Precipitation in Nebraska was 69 per cent of normal and in Colorado 65 per cent.

(Continued on Page 120)

You can see the "QUALITY" in Davis Products!

THE DAVIS NO. 60 FLOAT VALVE

THE No. 60 Float Valve illustrated at the left, with a close-up of the valve construction, is an example of Davis' ability to give *plus* value even in one of the most common types of valves:

1. The Famous Davis Single Seat-Pilot Stem valve! Tight closing and non-sticking. Standard sizes will open against any pressure up to 125 lbs.

2. No internal packing! Disc renewable easily and economically. Hot or cold liquid at high or low pressure handled without hunting or water hammer.

3. Sizes 3" and smaller are all brass valves. Larger sizes have semi-steel body, and bronze bonnet, piston and trim. Globe or angle body patterns.

"QUALITY" is not hard to find in Davis products—particularly if you are an operating man. Throughout the entire Davis line, you will find feature after feature that has been developed to give you the kind of performance . . . convenience . . . and durability you want! We are always glad to give you complete information about each Davis item; construction materials . . . capacities . . . service qualifications. Take advantage of this service to insure yourself of getting better installations. The Coupon is for your convenience.

"I got some good ideas out of these bulletins"

Perhaps You Could, too —

Davis Regulator Co.
2508 S. Washtenaw Ave., Chicago

Without obligating me, please MAIL literature describing:

- ☐ Pressure Regulators and Pump Governors (including service and capacity charts).
- ☐ Strainers.
- ☐ Pressure Relief, Back Pressure, and Exhaust Relief Valves.
- ☐ Liquid Level Controllers for closed tanks.
- ☐ Lever and Float Operated Valves.
- ☐ Solenoid Valves for Industrial Service.
- ☐ Stop and Check, Non-Return, and Balanced Check Valves.

☐ A specific problem is outlined on the attached sheet. We would appreciate your recommendations.

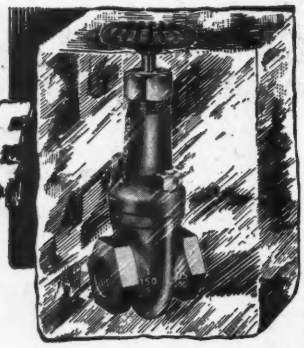
Name .....

Company .....

Street .....

Town..... State .....

Cannot FREEZE or CLOG



Relief slots on the threaded bonnet bushing of Fairbanks U-Bolt Gate Valves insure drainage back into the body chamber. This eliminates freezing, clogging and excessive stem thread wear.

This and the following make the Fairbanks better "service" valves.

Extra deep stuffing box, with follower gland and compression packing, insures a tight spindle joint. Back seat is above stem threads for repacking when wide open under pressure. Sediment cannot reach it. Male and female body and bonnet joint, fitted with high-pressure steam gasket, make a tight leak-proof fit.

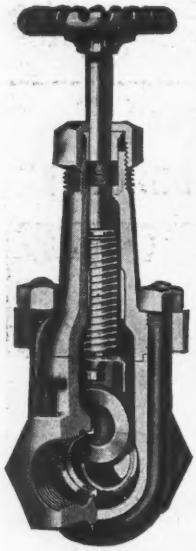


Fig. 0417

Large diameter bronze spindle, with more than five threads in contact with bonnet bushing. Reversible double-taper horse-shoe type, knife-edge wedge for cutting through heavy viscous fluids. Bronze seats carefully gauged for tight fit with wedge. Body and bonnet made of Fairbanks Semi-Steel, having an average tensile strength of 40,000 lbs. per sq. in.

The All-Iron pattern has a steel spindle and iron packing nut, follower gland and wedge. Seats are integral with the body, accurately machined for tightness.

When a husky, inexpensive valve that can be easily taken apart for cleaning or inspection is required, or where there is a tendency to corrode, try Fairbanks U-Bolt Valves.

Sold by distributors everywhere. Write for Fairbanks U-Bolt Catalog.

THE FAIRBANKS COMPANY

399 Lafayette St. New York, N. Y.

Boston—Pittsburgh

Distributors in Principal Cities

Factories: Binghamton, N. Y., Rome, Ga.

FAIRBANKS U-BOLT GATE VALVES

Stream flows in the drought areas during the past year were as low as 26 per cent of normal, and to date the flow has not increased appreciably. In West Virginia, the stream flow during the 5-month period August-December in three streams averaged only about 30 per cent of normal.

The flow of the Red River at Fargo, North Dakota, which was zero during September, has increased to an average of 16 second-feet; the flow during the period between October 1, 1938, and September 30, 1939, averaged 179 second-feet, which in itself was only 41 per cent of normal.

In the Tennessee River Basin where the runoff for the calendar year was practically normal, the discharge this winter has approached the minimum of record, being 1,650 second-feet on the Tennessee River at Knoxville, November 15, compared to the minimum of record of 1,390 second-feet reached in September, 1925.

Expansion in Pennsylvania Industries

PENNSYLVANIA industries and utilities during 1939 have reported expenditures of $194,846,109 for new plant construction and equipment which were started or scheduled, according to a statement from the State Department of Commerce. Representative plants of scores of the state's important industries in every section of Pennsylvania reported they are enlarging their productive capacity. The figure is more than twice as large as the total of new capital investment in Pennsylvania industry in any recent year, and exceeds the figure for any other State in the Union for 1939.

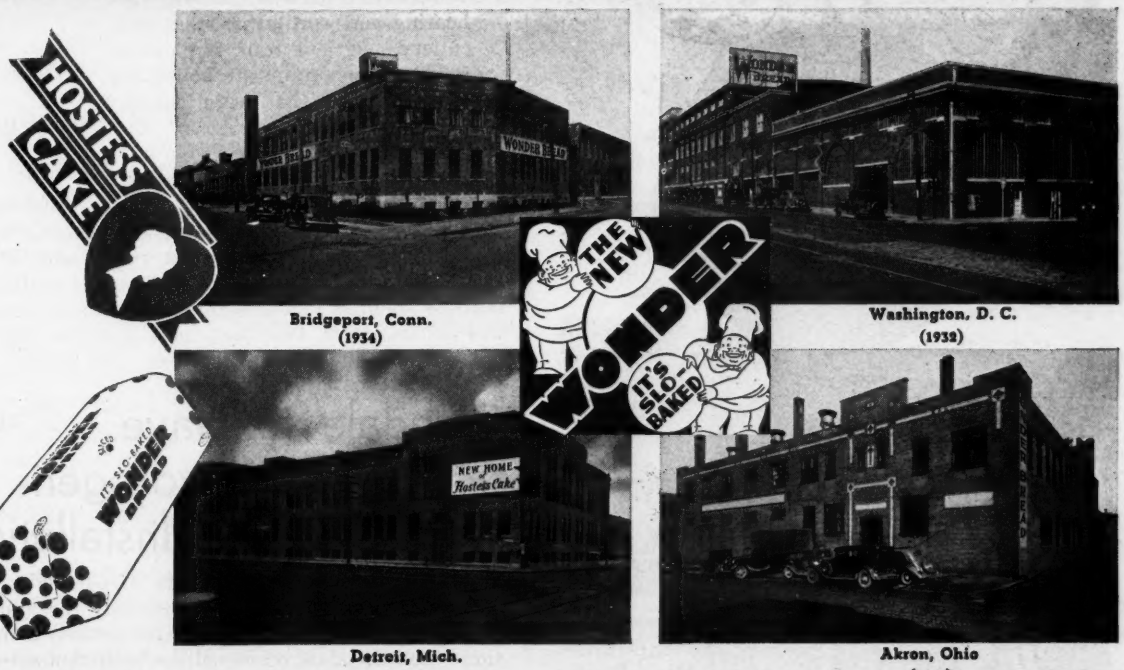
Included in the expansion program is approximately $64,000,000 scheduled in 1939 for 1940 expenditure. This assured volume for the new year will furnish work for many thousands in Pennsylvania in the construction industry and the production of new equipment.

The impressive total is significant of Pennsylvania's broad industrial forward movement. In contrast with the flight of industry from the State several years ago, manufacturing plants now are expanding at home. A part of the expansion was in location of new industries to supply Pennsylvania's home market with products which residents had been buying beyond the State's borders. More of it came as established Pennsylvania industries began expanding because under the new State laws and policies they are in better position to compete with their rivals in other states than they have been in years. And a sizable development has been started by the utility companies of Pennsylvania to enlarge their facilities in order to be ready to serve Pennsylvania's expanding industries.

The expansion is widely representative of Pennsylvania's highly diversified industry, and the survey shows it was in evidence on a state-wide scale. For instance, expansion begun among several of the

(Continued on Page 122)

17 CONTINENTAL BAKING PLANTS



Bridgeport, Conn. (1934)

Washington, D. C. (1932)

Detroit, Mich. (1929)

Akron, Ohio (1935)

USE 20 DETROIT STOKERS

A Remarkable Record of Satisfaction

1929 Detroit, Mich. (Hostess Cake)
1931 New Haven, Conn.
1931 Boston, Mass.
1932 Washington, D. C.
1932 Cleveland, Ohio
1934 Indianapolis, Ind.
1934 Bridgeport, Conn.
1935 Dayton, Ohio
1935 Akron, Ohio
1936 Holyoke, Mass.
1936 Springfield, Mass.
1937 Buffalo, New York
1937 Cleveland, Ohio
1937 St. Louis, Mo.
1938 Youngstown, Ohio
1939 Detroit, Mich. (Hall Baking)
1940 Detroit, Mich. (Wonder Bread)

WRITE FOR BULLETIN No. 524

DETROIT STOKER COMPANY

Fifth Floor, General Motors Building, Detroit, Michigan • Works at Monroe, Michigan
District Offices in Principal Cities • Built in Canada at London, Ontario

THE ABOVE, well expresses the capabilities of the Hays Slack Leather diaphragm draft measuring unit—able to withstand tremendous pressure or suction, yet so sensitive it can measure increments of only .0025 of an inch water.

Hays pioneered the dry type of draft gage which today is still considered the standard for accuracy, versatility and long life. There are many styles with which to meet the differing requirements of the modern power plant, to be mounted either separately or with other instruments and control units on a panel.

Hays diaphragm type draft units are so compact that as many as 24 have been mounted in a single case. A five unit gage is shown above at the left.

There is a Hays representative near you. . . .

Write to HAYS at 910 Eighth Avenue, Michigan City, Indiana, for specification literature and catalog—no obligation.

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROLS
MICHIGAN CITY, INDIANA, U.S.A.

manufacturing groups in 1939 included:

Steel	$18,502,142.00
Coal Tar products, oils and gasoline refining, drugs and other chemicals	17,878,119.00
Machinery and other metal working, including locomotives, electrical machinery and apparatus, motor vehicles and parts, aluminum ware, heating and ventilating equipment, cutlery, agricultural implements, refrigeration equipment, boilers and tanks, engines, hardware, machine tools, and elevators	13,660,491.00
Building materials, cement, glass, refractories, and other clay, glass and stone industries	8,400,863.00

The figures gathered in the department's suvey include expansion by manufaturing and utility plants only, and do not include the many additional millions spent in Pennsylvania upon enlarged stores, warehouses, farm buildings, new gasoline stations, office buildings, apartment houses, and homes.

Glendale to Have Outdoor Hydrogen-Cooled Installation

FOR A new station at the city of Glendale, Cal., the General Electric Co. is building the first hydrogen-cooled turbine-generator for outdoor installation. The Glendale plant will be built at a substantial saving over the conventional type because of the absence of heavy building structures, and is looked upon as the forerunner of an entirely new trend in power plant design. The boilers and firing aisle are to be enclosed with stucco-covered light-steel frame housing, and the turbine-generator unit will be located upon an open deck and served with a traveling gantry crane.

Outdoor-type stations are particularly suited to California with its prevailing moderate weather, and it is economically attractive because power plant building costs there are normally somewhat higher than in other areas due to the necessity for earthquake-proof construction.

Turbine-generators can be installed outdoors in any part of the country, however, in the opinion of G-E turbine officials. According to R. S. Neblett, assistant manager of the company's turbine division, outdoor type stations are feasible for all sections and all climates of the United States.

(Continued on Page 124)

Long Live BEARINGS!

Three ways to help: consider the effect on your oils of LOAD, of HEAT, of CONTAMINANTS

LET'S LOOK at bearing lubrication through the eyes of your plant engineer—a highly practical person. He usually does little talking about lubrication theories. He sees lubrication as one of the important means to the end he's after . . . which is to give you all the operating efficiency your machines can deliver at the lowest cost.

But he's thinking always of your actual machines—some of which have to work under abnormal conditions. Does it pay you to run one of them at a fairly consistent overload? Very well; he'll just have to adjust his lubricant to that overload. Perhaps another one has to inhale a lot of sulphur; a third works in atmosphere choked with dust. He'll just allow for those contaminants in figuring what oil best does the job, and how best to purify it.

Among the many conditions he deals with, in choosing and controlling his lubricants, he's certain to lay emphasis on these three: operating *loads;* range of bearing *temperatures;* extent and kind of *contamination.*

The Load on a Bearing

The job of a bearing lubricant, stated simply, is, of course, to form an oil film that keeps the metal of the journal from touching metal of the bearing. It's always easy enough to agree on basic theories.

But let's suppose that in one of your bearings you've figured on a normal unit of pressure of 500 lbs. per sq. in. Under that load the oil you're using maintains a perfect oil-wedge formation, like that in Fig. 3 above. Later, it happens to make sense for other reasons to throw an extra 200-lb. load on that bearing. As the journal is pulled downward, the oil film on the pressure side becomes thinner . . . and thinner. Does it reach the danger point? That depends on what adjustments your engineer has made in his oil.

How Much Heat?

Yet he can never deal with this problem in isolation. He must at the same time keep in mind the bearing temperature. Temperature, as you know, acts upon oil viscosity both as cause and effect. Is viscosity too low? The oil may be squeezed out—result: metal-to-metal friction—and up goes the heat. Yet too heavy an oil sets up excess fluid friction, generating and holding heat: bad first for the oil; soon after, hard on the bearing.

Here, too, your engineer gets the effective lubricant only by considering in each of your bearings *all* the factors that may alter the temperature.

Three Stages in the Formation of the Oil Wedge

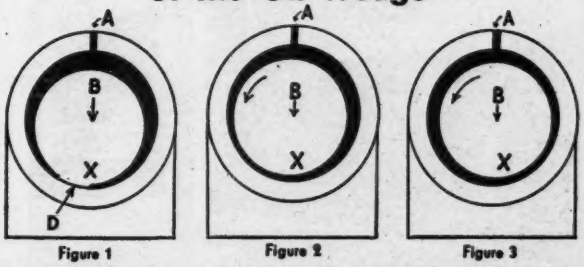


Figure 1 — Journal (X) at rest. Metal-to-metal contact and high-pressure point at (D). Load (B) vertical. Lubricant-introduction point at (A).

Figure 2 — Journal (X) starting in motion. Oil film and wedge create high-pressure point where metal-to-metal contact existed in Fig. 1.

Figure 3 — Journal at full speed. High-pressure point has moved to the right following direction of journal motion and pressure of oil wedge.

Contamination—and Control

Then there's the question of contaminants of all kinds. Your engineer never forgets the active agents that set busily to work on a fresh lubricant as soon as it's in. He has to know where oxidation may occur with each lubricant. He knows when the resulting sludge is apt to fill up oil grooves or clog feed lines.

At least, he knows all these things to watch for, and many others, too, if he's going to insure your bearings the care that they deserve. Shell has often helped, from its years of experience in a variety of bearing problems, to supply the one or two clues which may be all you need to improve your bearing operation or to lower your operating costs. Call in your Shell lubrication man. You and he have the same end in view . . . longer life for bearings.

SHELL

SHELL Industrial Lubricants

Insist upon the welding fittings that alone combine these eight features.

TAYLOR FORGE
WeldELLS
Seamless Pipe Fittings for Welding
★ Trade Mark Registered

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"Hydrogen-cooling makes the outdoor installation of turbine generators a practicability," Mr. Neblett points out. "Such machines are completely self-contained, and are hydrogen tight and air-tight, making their operation independent of weather conditions and changes."

Basically, the Glendale unit will be the same as a hydrogen-cooled turbine generator built for conventional installation indoors, except for a welded sheet-steel housing over the high-pressure end of the turbine proper. Control panels will be located in the station basement.

Rated 20,000 kw., 13,800 v. at 3600 r.p.m., the unit will operate at 0.8 power-factor and have a total output of 25,000 kv-a. It will use steam at 600 lb. gage pressure, with a back pressure of 2 in. of mercury absolute. Shipment is scheduled for August, 1940.

Two other outdoor turbine generators, a 20,000-kw. and a 6000-kw. unit, both air cooled, have been operating at Schenectady throughout the past seven winters, some of which have been the most severe on record.

Hydrogen-cooled machines installed indoors and now in service total more than 1,000,000 kv-a.

Fuel Burning Equipment

OFFICIAL figures, on the sales of fuel burning equipment for the year 1939, have just been released by the U. S. Department of Commerce. Various trends show a definite increase in sizes and number sold.

Pulverizers

The following table shows that although the number of pulverizers sold in 1937 is greater than in 1939 there has been a decided increase in the size. From the table it will be noted that the average size of the pulverizers sold in 1937 was 8879.12 lb. of coal per hr. Comparing this to the average size in 1939 shows an increase of 37.56 per cent.

Year	Total No. of Pulverizers Sold	Total Capacity in lb. of coal per hr.	Average Capacity of Burner in lb. of coal per hr.
1937	375	3,319,670	8,879.12
1938	137	1,487,070	10,854.52
1939	274	3,345,467	12,209.37

Stokers

Factory sales of mechanical coal stokers in 1939 broke all records. The 101 manufacturers who reported sold 104,289 stokers compared with 96,433 units in 1938 and 101,808 machines in 1937; an increase of 8.1 per cent over 1938 and 2.4 per cent over 1937. These figures include all kinds and sizes of stokers, of which 3132 in 1939, 2415 in 1938 and 3287 in 1937 were of those having a capacity of 301 lb. of coal per hr. or more which are the sizes most commonly used for the generation of steam for power purposes. The manufacturers whose data are included in these statistics produced approximately 95 per cent of the total dollar volume of the output of the industry as reported in the Census of Manufacturers for

(Continued on Page 126)

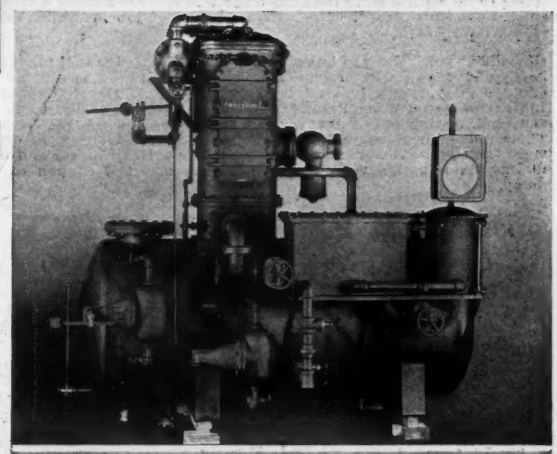
Here's a way to get still greater

SAFETY·EFFICIENCY·ECONOMY

in your Power Boiler Operation

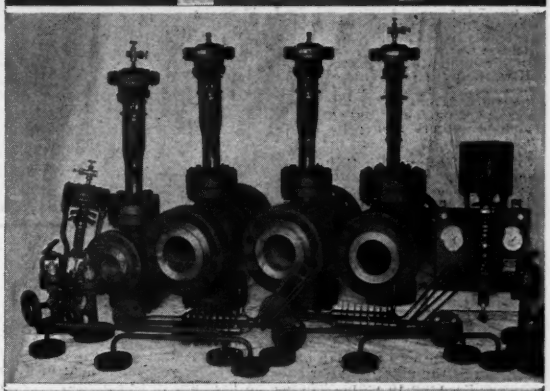
Swartwout Equipment

for sure automatic cost-saving control of feed water and steam



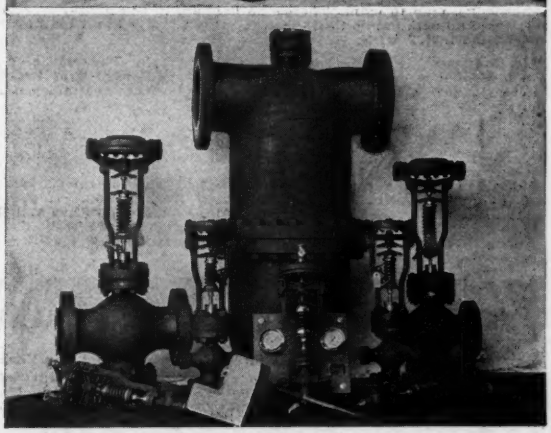
FIRST Feed Water Heating and Deaerating

You must have oxygen-free hot water, supplied continuously under severe operating conditions. Swartwout Deaerating Feed Water Heaters assure this constant service — have proved their sound, safe construction for years with *guaranteed* trouble-free results. Note the rugged construction in this metering deaerating feed water heater built for the Federal Jail at Milan, Michigan.



SECOND Feed Water Regulation, Pump Control

You must have sensitive, positive feed water regulation. The Swartwout "S-C" Feed Water Regulator is a simple, dependable system which guarantees correct water supply. You save in original installation cost, in operating and in maintenance cost. Here is feed water regulation and pump control equipment ready for shipment to Hartford (Connecticut) Electric Light Company, now operating on 900 pounds w.s.p. boilers.



THIRD Reducing and Desuperheating

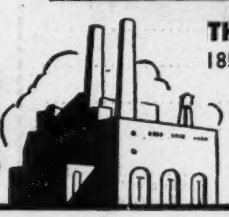
You must be sure of safe, rigidly controlled reducing and desuperheating. A station engineered, designed, built and serviced by Swartwout places the responsibility in *one place,* with guaranteed, completely satisfactory performance. The station shown here was built for and now operates on 900 pounds w.s.p. at a large central station in Brooklyn, New York.

● *Swartwout engineered controls positively assure you of the safety, efficiency and lower costs you want, as they've done for years for thousands of satisfied users. Write or call us today.*

Feed Water Regulators • Pump Governors • Feed Water Heaters
Master Controls • Reducing Valves • Separators • Exhaust Heads

Swartwout

•Power Plant Equipment•



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Controlled **AIR CIRCULATION**
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Are You Equipped to Hold Your Job?—to Get a New One?

The men who are keeping their jobs today—who are not feeling the whip of competition—are those who have kept one jump ahead of their jobs. They are the men who are equipped with a thoroughgoing and growing knowledge of the business they are in.

It works in the power plant field as well as in any other. Some men fit themselves to do a little more than their job calls for. They fit themselves to do a little more than the other fellow. They make a steady effort to equip themselves with the best kind of job insurance there is—KNOWLEDGE.

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(Books sent on approval in U. S. and Canada only.)

1937. It is conservatively estimated that, taking into account the sales of minor companies not reporting to the Government, there were approximately 110,000 stokers sold in 1939 with a small unknown percentage shipped to foreign countries. Unknown also is the number of new stokers sold and installed in 1939 which replaced old or obsolete models.

Oil Burners

Data reported by 178 identical manufacturers shows that 215,030 oil burners were shipped in 1939, an increase of 54.5 per cent from 139,211 burners shipped in 1938 and 11.3 per cent from 193,180 burners shipped in 1937. These figures refer to oil burners and oil burner units consuming fuel oil of Commercial Standard No. 1 grade and heavier used for application to central heating plants, to industrial process equipment and for generation of steam for power. Burners used in ranges, stoves, water heaters and space heaters are not included in this report.

Trends in Stoker and Coal Industries

IN CONCLUDING a paper on the small stoker industry read before the Detroit Coal and Stoker Institute, Marc G. Bluth, secretary of the Stoker Manufacturers' Association, expressed the following hopes and predicted future trends in the stoker and coal industry, as follows:

An increasing number of so-called "stoker manufacturers" discontinuing the line;

Diversification of business by stoker manufacturers in developing a general line of heating equipment;

The need for more extensive research work on fundamental principles of coal combustion and classifications of bituminous coals as applied to small underfeed stoker firing;

A terrible need for complete stoker-boiler and stoker-furnace units—"packaged" heating units to meet competition in the new home building field;

The need for mechanical or automatic removal of bituminous coal ash, but recognition by all interests concerned of the fundamental problems and obstacles encountered in the designing, developing and marketing of such equipment;

125,000 stoker sales this year;

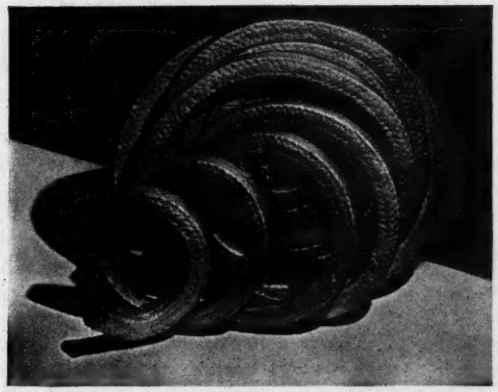
The increasing need for an industrial training program for installation and service men;

The recognition of the value of local cooperative advertising and sales promotion efforts between coal retailers and stoker dealers;

The expansion of national advertising and sales promotion efforts, particularly by the National Coal Association, which is already engaged in such activity and has been for the past two years;

The utmost importance of personnel and manpower and intelligent supervision and training of salesmen and mechanical men.

KEEPING 'EM ROLLING — By WESTCOTT



J-M INTERLOCKED: This packing is the latest development of the J-M Packing laboratory. Strands of asbestos yarn are tightly interlocked to form a solid, square braid that cannot ravel or come apart.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville

PACKINGS & GASKETS

TOM'S ANSWER... *Buy J-M Interlocked Packing and Reduce Shutdowns*

EVERY time you replace a packing, you lose far more than the bare material costs. Time, labor and general shutdown charges make up your real expenses. And those are the costs you reduce with J-M Interlocked. This new-type J-M Packing represents the greatest single improvement ever made in braided packing. It's braided solid . . . has no layers to wear through . . . cannot come apart or ravel. It gives the longer, more efficient service that's typical of the complete J-M line.

For details on Interlocked and other money-saving J-M Packings and Gaskets, send for the new J-M Packing Catalog. Johns-Manville, 22 East 40th Street, New York, N. Y.

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WARE HI-LAG FUSES

Start your plant economy program around the improved WARE HI-LAG Fuses.

The exceptionally high time lag of WARE HI-LAG Fuses ends the blow-outs often caused by starting motors and momentary surges.

The new double-bridge, self-aligned assembly used on these WARE HI-LAG Fuses is easy to renew and insures extra strength and longer life. Assembly may be inserted either end first.

WARE HI-LAG Fuses are Underwriters approved; give 100% protection to your circuits; soon pay their cost through saving of lost time. Write for our Trial Test Offer, sizes and prices.

WARE BROTHERS

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Tensile Strength Calculations Baffle Scientists

SCIENTISTS, it seems, are baffled by the problem of tensile strength of metals, according to statements by Dr. Saul Dushman of the General Electric Research Laboratory at a recent meeting of the Detroit chapter of the American Society of Metals. Some properties of metals can be calculated accurately on paper, but the ultimate tensile strengths of metals, he explained, are only one-tenth to one-hundredth of what theoretical calculations of the physicist say that they should be. Just why calculations cannot be made more accurately is the puzzling problem.

"On the basis of the electronic theory of atomic structure and quantum mechanics," Dr. Dushman said, "it is possible to account for the typical metallic properties such as electrical and thermal conductivity, the occurrence of magnetism for some of the metals, and observations on the relation between composition and phase patterns for a number of alloys.

"In the case of the alkali metals and copper it has been found possible to calculate heat of evaporation and compressibility from the known electron configurations of the atoms.

"However, such 'structure sensitive' properties as tensile strength, rate of creep under stress, especially at higher temperatures, phenomena of recrystallization and age-hardening, etc., cannot be interpreted on any purely atomic basis.

"It seems to be generally accepted that fine cracks or similar defects in crystalline structure account for the discrepancy between observed and calculated tensile strengths. For instance, the ultimate tensile strength increases with decrease in size of wire, with decrease in grain size, and with increase in cold working.

"G. I. Taylor, Becker, Orowan and others have developed a theory of plastic deformation under stress and of rate of creep. The observations on effect of temperature on ultimate tensile strength, rate of creep, and life to rupture are important, although we do not understand the significance of the observed 'activation energy.'

"The observations in which the metallurgists is interested are so varied and so extremely complex that progress towards a satisfactory explanation must necessarily be slow. We are dealing in nearly all cases with phenomena in which the energy changes involved are relatively small, and to calculate them involves from the point of view of atomic structure, a consideration of second-and third-order perturbation effects. What we need at present is not so much a study of engineering materials as of pure metals and simple binary alloys."

Dr. Dushman listed cohesion and plastic deformation as the most important metallurgical problems.

(Continued on Page 130)

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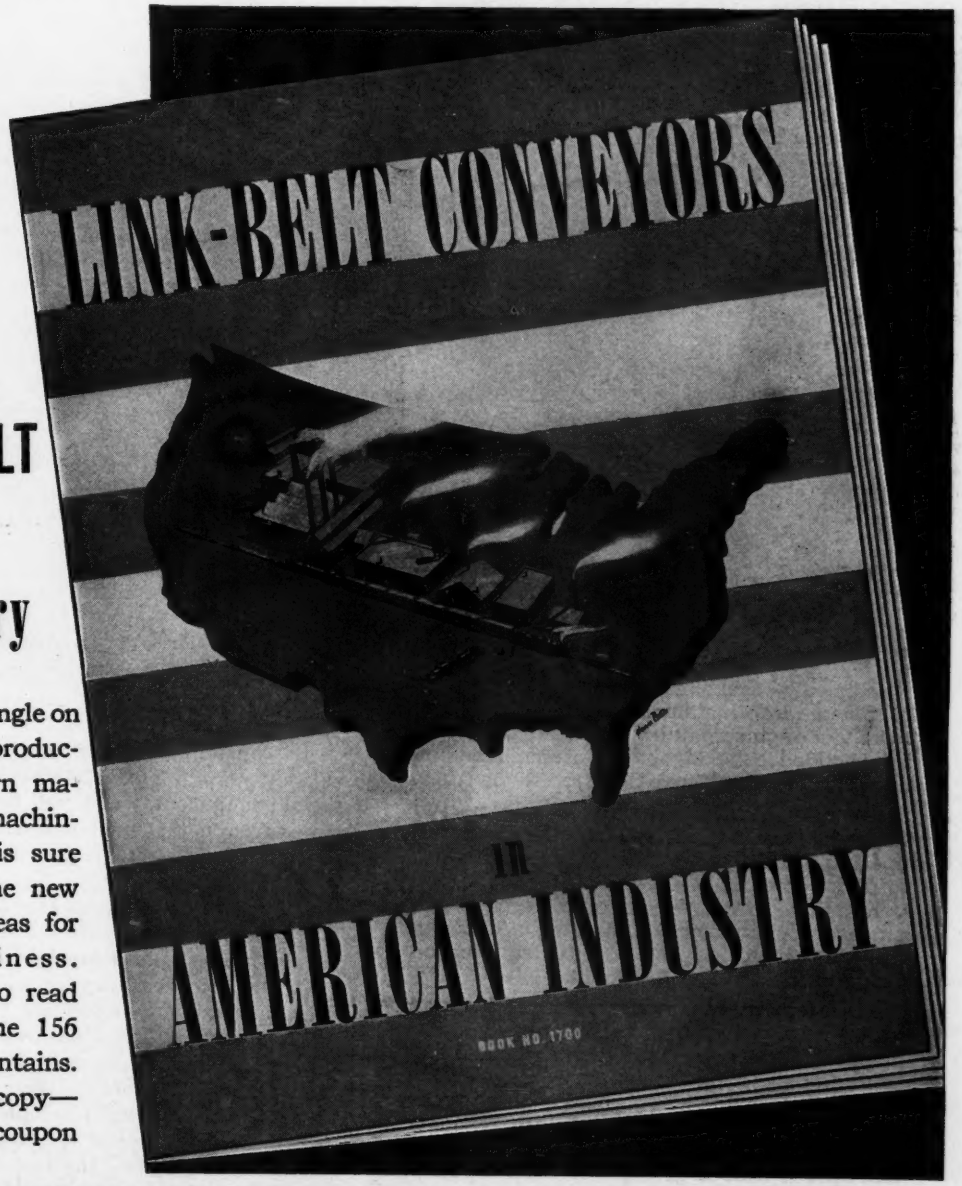

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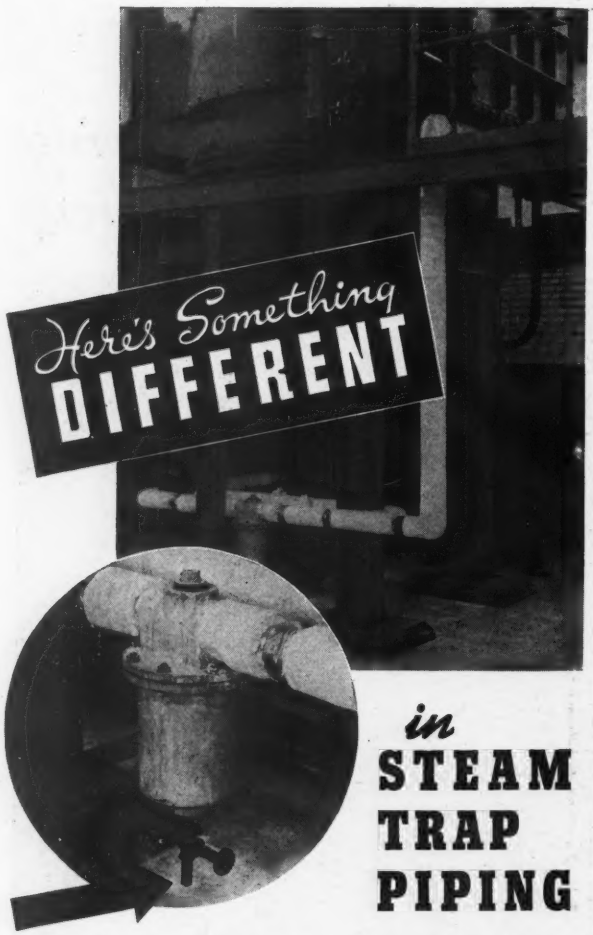

in
STEAM TRAP PIPING

A sediment pocket and blow-down at the bottom of a steam trap *is* different. And that is a new twist that engineers at Industrial Rayon Corporation added to the advantages of simplified piping with Anderson Super-Silvertop steam traps.

Since the vertical inlet tube reaches almost to the bottom inside this steam trap, the drain plug opening just below the tube is the logical place to attach a sediment pocket and blow-down valve. Have you ever seen a more clean-cut, practical piping layout? (Trap is a No. 25 Super-Silvertop installed at the Industrial Rayon Corporation's Painesville plant.)

Another feature of the Anderson Super-Silvertop trap is guided bucket—a bucket-on-a-track confined to straight line motion—a bucket controlled in true engineering fashion to open the valve wide and close it tight. This design also permits a larger bucket in the same size case and a longer lever arm. These together open a larger valve and open it wide to give greater trap capacity.

Find out more about Super-Silvertop. Join the thousands of satisfied users who no longer put up with complicated puzzle piping and swinging bucket – write today for complete details and prices.

THE V. D. ANDERSON COMPANY
1939 WEST 96th STREET • CLEVELAND, OHIO

SUPER-SILVERTOP STEAM TRAPS

He said that tensile strengths of metals are not only considerably less than those calculated on a theoretical basis but that tensile strength and other cohesive properties may be varied over large ranges by varying the composition, by heat treatment, and by mechanical working.

Investment Calculations

By JAMES O. G. GIBBONS

MOST PRACTICAL operating men, both in the power and production departments, from time to time, encounter conditions which make it apparent, that an investment in improved machinery or equipment, would be a paying investment, but when they try to sell the idea to those responsible for the financial end of the business, they find themselves handicapped by their lack of knowledge as to the correct method of figuring costs, and as the financial men often seem to think, that their real job is to spend as little money as possible, regardless of results, it may be useful to call attention to a very common method of figuring investment costs, which is both simple and easy, but which, like many other simple and easy things, is entirely misleading.

Let us suppose that you figure that, by the investment of $1,000, in new or improved equipment, you can save an extra $250 a year, or 25 per cent on the investment, before allowing for interest, etc., and you go to the management and recommend that this money be spent. You will very likely meet with something like this.

Investment $1,000.00	
6% interest on $1,000.00	$ 60.00
Depreciation (20 yr., estimated life) 5%	50.00
Taxes	20.00
Total	$130.00

So, we only save $120 a year, and we are not entirely certain of that, then again; what about the old equipment, which will be replaced? we shall have to scrap that, and it is now being carried on the books as an asset. It does not look good enough.

What is the answer?

Error in Interest and Depreciation

In the first place, there is a serious error in figuring the interest and depreciation.

If we lay aside $50 a year, which should of course, draw interest and depreciate the equipment from $1000 to 0, in 20 yr., the average investment during that time will be only $500, and 6 per cent on that, is $30, which is the real average interest charge. Then again, it is unlikely that taxes are paid on the first cost of the machinery, so whatever the tax rate may be, the tax estimate is probably too high, and may be cut in half. After this, we get a yearly charge of $90 instead of $130, which is another 4 per cent on the original investment, so we have a net return of $250—90, or 16 per cent on $1000, and at the end of 20 yr., we should have $1000 on hand for renewing the equipment.

Another thing to be kept in mind is that, in all probability, our machine which has been depreciated

(Continued on Page 134)

A NEW SERVICE

TO PUMP USERS

WARREN'S PUMP AUDIT REVEALS HIDDEN POWER LOSSES

POINTS WAY TO SAVINGS

Here, for the first time, is a straight-forward way to get at the real facts about pumping efficiency in your plant. If your pumps have been in service for periods up to ten years or longer, chances are that power consumption and maintenance charges are out of line with today's standards. The "Pump Audit" will help uncover these losses, enable you to match your pumping costs against those obtainable with modern, efficient pumps.

On the basis of this thorough check-up, which may be made with the help of Warren engineers, you can reduce these power losses by a well planned program of pump replacement. For the full story on the "Pump Audit," see your Warren representative, or write.

WARREN PUMPS

WARREN STEAM PUMP COMPANY INC., WARREN, MASS.

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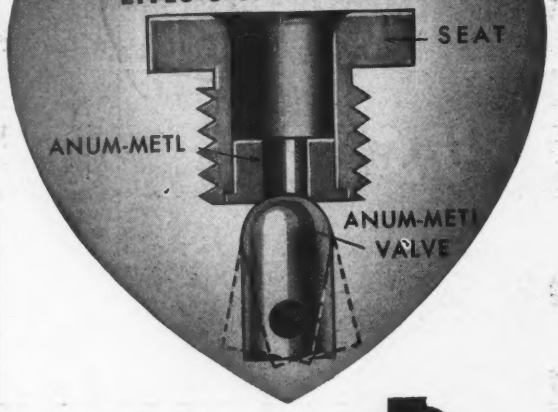
PIPEWRENCH PETE SAYS:

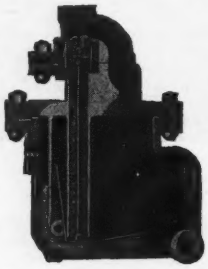
3 OUNCES OF ANUM-METL CAN SAVE 30,000 POUNDS OF STEAM A MONTH!

"HEART" OF ALL STRONG TRAPS LIVES 8 TIMES LONGER!



STEAM LEAKS COST MONEY!

Diam. of leak	Lbs. steam wasted per 100 lb. press	Cost per mo. at 50c per M lbs.
¼"	203,000	$101.50
⅛"	50,500	25.25
1/16"	12,750	6.38
1/32"	3,175	1.58



"Regular" open Bucket Trap — recommended for any condensate drainage job as "the most economical and dependable trap built."

MAKE THIS *Money-Back* TEST IN YOUR OWN PLANT!

Don't miss this opportunity to test, *in your own plant,* production and steam savings made possible by Strong's amazing ANUM-METL valves and seats!

By actual test, they keep Strong open and inverted bucket traps leakproof 8 times longer than the long-lived metal they replaced. They are *guaranteed* leakproof for one year.

Try the correct Strong traps for 3 months. Then agree they are your best buy *regardless of price,* or return them and get your money back, *plus freight!*

HOW DO YOU SIZE TRAPS? Practical, easy way described in Catalog 83-PE4. Send for it today.

The Strong, Carlisle & Hammond Company
1392 West Third Street, Cleveland, Ohio

STRONG
STEAM TRAPS

to nothing, will have a scrap, or resale value, don't forget to ask credit for that, it will help your cause.

The accountants may object, that, in accordance with accounting practice, nothing can be written off for depreciation, until the end of the first year, so the average interest cost is somewhat higher than you figured, but, this is merely a technical quibble, ask them why, as the equipment begins to earn money, including depreciation and interest charges, immediately it goes into operation, it should have to wait a whole year before it gets any credit for it.

The next thing to consider is, "How about the present investment?" and here you had better be prepared with a good answer. Above all things, do not underrate the seriousness of this objection, it is often a question of what our Oriental friends would call "Saving face," and don't think that is not a serious matter.

We have on our books, an investment for the old equipment, of say, $600, which we either have to write off or add another $1000 to it.

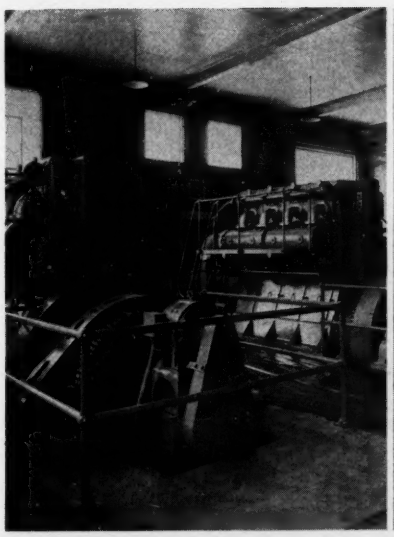
As a practical man, you will probably say "write it off, and forget it," but you must not forget that there is another entirely practical question involved, and that is, how to explain a loss from the assets of $600, or how to explain the existence of items in the assets account, amounting to $1600, with only $1000 of useful equipment to account for it.

This is a real problem and you had better give it serious consideration before going to the people higher up with your proposition. If you can think up a reasonable method of taking care of the old equipment on the books, you will have a fair chance of selling your ideas; if you cannot, you will probably be turned down.

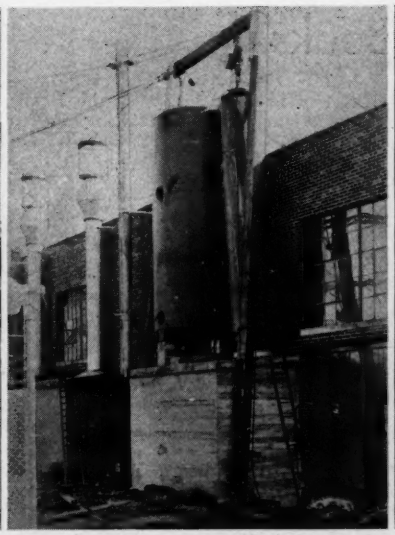
If you have estimated your savings correctly, you have already taken care of a reasonable return on the present value of the old equipment. It is reasonable to assume that the value of this is the cost of purchasing similar equipment today, less the percentage of its expected life, which has already expired. If the accounting department has been doing its job right, which is sometimes doubtful, it should have already taken care of this on the books. In any event, don't let anyone fool you that there is any justification for carrying the old investment at a higher valuation than the above.

You will see that if proper yearly depreciation is made on the old equipment, the investment will eventually write itself off and your problem is to find a good excuse for keeping it on the books at a constantly lessening value until the time that this occurs.

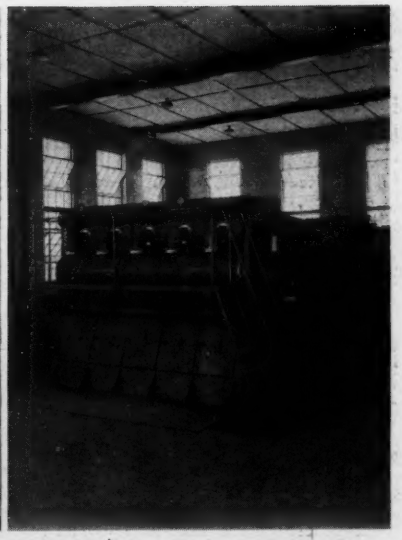
You had better give this serious consideration. It will probably "make or break you," and don't object that this is a pure fake. In any event you can probably find some real use for the equipment if only as a standby. As a matter of fact, all values are more or less "fakes." They depend to a large extent upon earning values, and really little upon first cost and depreciation, although that is how they have to be handled for accounting purposes; and what is more, too often depreciation is very much of a hit and miss proposition and has little to do with actuality.



Power plant at Primghar, Iowa, equipped with Burgess Snubbers.

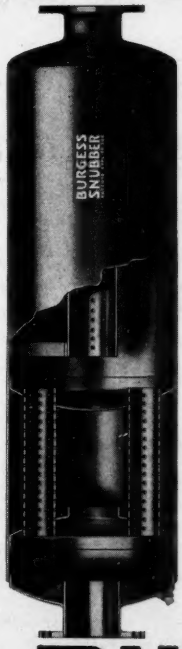


Installing Burgess Intake and Exhaust Snubbers in power plant at Sturgis, Michigan



Power plant at Forest City, Iowa, equipped with Burgess Snubbers

STOP COMPLAINTS about Exhaust Noise



Here's the way to quiet your engine exhaust noise without conventional muffling, silencing, or building up line surges —just install a Burgess Snubber and you will eliminate the *cause* of engine exhaust noise.

"Snubs the Slug"

The Burgess Snubber operates on an entirely new principle. It "Snubs the Slug" of exhaust gases—dissipating the high pressure slugs before they detonate and create a violent disturbance in the atmosphere. Instead of muffling, Burgess Snubbers actually prevent noise.

No Back Pressure Peaks

The Burgess Snubber not only prevents exhaust noise, but it provides an unrestricted passage through the exhaust system for the gases discharged during the scavenging stroke. The exhaust gases are vented smoothly with no back pressure peaks. Fuel consumption is not increased, because line surges, frequently set up in conventional muffling systems, are avoided.

Needs No Tuning

The Burgess Snubber is a non-tuned unit. It has no resonator chambers. It will operate on exhaust piping systems of any length, on any type of engine, at any engine speed. It is compact and light but built to last in severe service.

BURGESS SNUBBERS

Patented and Patents Applied For

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New Engineering Books

Gas Engine Handbook. Published by the American Gas Association, 420 Lexington Ave., New York City. Edited by the Gas Engine Power Committee, D. W. Reeves, Oklahoma Natural Gas Company, Tulsa, Okla., Chairman. 8½ by 11 in., 56 pp., paper bound. Price $1.00 per copy.

This is a handbook of gas engines and gas engine power utilization and is based largely on data and information collected and arranged over a period of years by C. Remschel of the Southern Counties Gas Co. It is intended primarily to help those interested in the sale and application of gas engines. The data included and the arrangement of material in the book should have a widespread appeal to all types of engineers interested in this form of power. It includes chapters on the history, operating cycle, practical applications, auxiliaries, power take-off, protective devices, etc., fuel consumption, standby, waste heat recovery electrical data and methods of figuring cost of operation.

Insulating Materials.—Four technical papers comprising the A.S.T.M. Symposium on Thermal Insulating Materials: Factors Influencing the Thermal Conductivity of Materials by J. B. Austin; A Discussion of These Methods for Determining the Physical Properties of Thermal Insulation by H. H. Rinehart; One Consumer's Problems in Selecting Thermal Insulation by E. T. Cope and W. F. Kinney; and The Effect of Solar Radiation on the Heat Transmission Through Walls by F. C. Houghten, Carl Gutberlet and Albert A. Rosenberg, are included in a 125 pp. booklet together with the discussion of the papers. Copies can be obtained from the Headquarters of the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. Price $1.25 in heavy paper cover; cloth, $1.50.

Five simple alinment charts for use in concrete column design together with a discussion and instruction for their use are included in a 19 page paper bound bulletin No. 40 issued by the Engineering Experiment Station of the Virginia Polytechnic Institute, Blacksburg, Va. The price of the bulletin is 25 ct.

Reinforced Concrete Construction. By M. T. Cantell. Published by the Chemical Publishing Co., Inc., New York City. Size 5½ by 8½ in., cloth bound, 154 pages. Price $3.00.

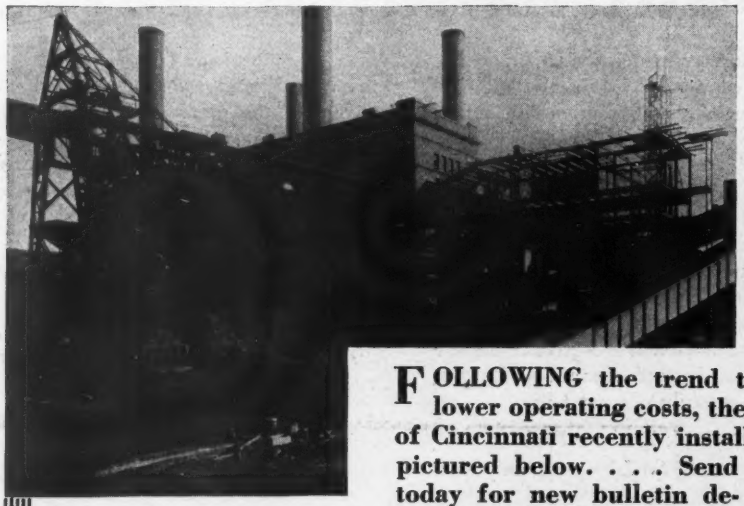
This is a practical book intended to give in as simple and direct a manner as possible information necessary to enable engineers to obtain a fundamental knowledge of reinforced concrete and its application in designing the principal members of modern structures. The value of the book for practical purposes is enhanced by the large number of examples which are worked out in detail. At first glance the book appears to be highly mathematical and for this reason it seems desirable to mention the opinion as expressed in the author's preface: From many years' teaching experience and in designing civil engineering and architectural structures, the author says he is well acquainted with the difficulty of students and draftsmen in studying work involving algebraical equations. He has, therefore, endeavored to overcome this difficulty by using simple mathematics throughout the work so that any college student or others who have not had academic training can easily follow the text. The author is Dean of the College of Arts and Science of the Pacific Coast University.

Wrought Iron—Its Manufacture, Characteristics and Applications. Second Edition. Published by A. M. Byers Co., Pittsburgh, Pa. Size 6 by 9 in., 97 pp. Price $1.00.

This newly revised handbook was published first in 1936 as a reference work for engineering organizations. This second edition has been completely rewritten and several new chapters have been added. This is the most complete and up-to-date work on wrought iron, its manufacturing processes, characteristics and fields of usefulness that has been published and should be of value to all members of the engineering and education professions.

Practical Electrical Wiring. By H. P. Richter. First Edition. 504 pages, 457 illustrations. 5½ by 8 in., cloth. Published by the McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. 1939. Price $3.00.

In preparing this book it has been the author's aim to make it simple



Sargent & Lundy—Engineers

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FOLLOWING the trend toward perfect coal sizing and lower operating costs, the Union Gas & Electric Company of Cincinnati recently installed the American Ring Crusher pictured below. . . . Send today for new bulletin describing Manganese Shredder Rings, Adjustable Grinding Plate and other features which make the American Ring Crusher a big dividend payer in power plants. Also write for bulletin illustrating Laboratory Crushers.

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enough for the beginner, yet complete enough so that it will be of value also to those already engaged in electrical work. It is intended to be not a manual that merely recites the methods used in wiring buildings for the use of electricity, but rather a book that explains the subject in such a fashion that the reader will learn both the way things are done and why they are done in that particular way.

Practical methods of electrical wiring explained in plain, easy language for the man who does it. Tells how to do all kinds of light and power wiring jobs in the home, farm and factory market and presents the basic principles behind them in clear, down-to-earth terms. Present fundamentals, terminology, basic principles, theory behind practices and practical wiring instructions all based on the National Electrical Code.

The Electric Power Engineer's Handbook. By W. S. Ibbetson. First edition. 250 pages, 110 illustrations, 5½ by 9 in., cloth. Published by Chemical Publishing Co., Inc., 184 Lafayette Street, New York, N. Y. 1939. Price $5.00.

This book has been written mainly for the use of the man who has control of any kind of electric power plant whether the engineer in charge of the central station or private plant, the sub-station attendant, the maintenance man or the electrical contractor. In fact, any marine, mechanical or civil engineer could find in it a ready handbook to knowledge of electrical power work. Systematic treatment is fully observed and urged throughout the book in preference to cut-and-dry methods which imply only a bare working knowledge of the operations. Simple descriptions aided by diagrams are an essential feature, and this especially applies to the sections on Plant Operation and Testing for Faults and Breakdowns. Owing to recent developments in A.C. supply, rectifiers have been given particular attention. In any instance where supervision of some kind of electrical plant is required, the book provides practical features absolutely necessary not only for the work in hand by to aid the reader in his search for knowledge of the subject.

Graphic Presentation. By Willard C. Brinton. First Edition. 512 pages, 250 pages with color, 6 by 9 in., flexible imitation leather. Published by Brinton Associates, 599 Eleventh Avenue, New York, N. Y. 1939. Price $5.00.

This is a book which deals with all sorts of methods for presenting information in graphic form. It results from the work of many people since the charts and illustrations which it contains were selected from thousands of sources. It contains examples of every form and type of chart and graph found by the author in more than 25 years of study of the subject. Twenty-five years ago, the author published a book entitled "Graphic Methods for Presenting Facts." Throughout these 25 years there has been a continuing demand for this book. This present book is another contribution to the field of graphic presentation and is written for general use rather than the technical field and along much the same general ideas as expressed in the former book.

The first part of the book, up through page 336, deals with "How to read a chart." The section from page 336 to page 452 treating the subject "How to Make a Chart" is necessarily condensed and gives suggestions rather than detailed instructions. The illustrations in the book were selected from the standpoint of interesting subject matter as well as to show representative types of graphic charts. Many of the charts are in color.

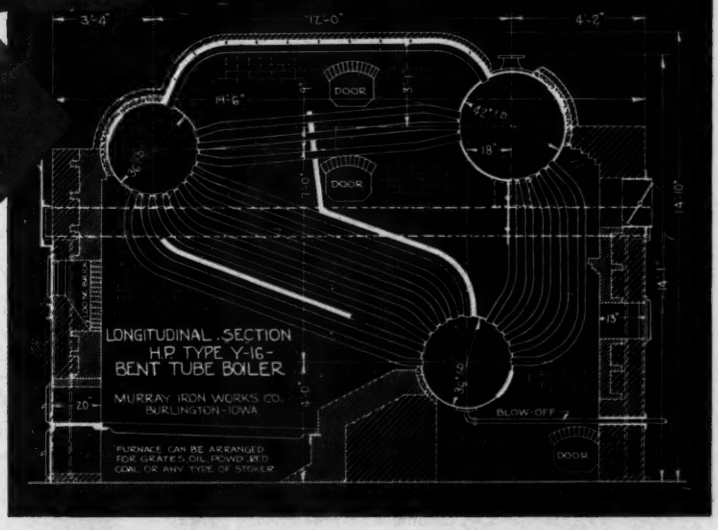
Although intended for general use, engineers as a class should find this book even more useful than the non-engineer. The engineer is already quite familiar with methods of presenting data in graphic form, and this book will be of interest if for no other reason than the very variety of its contents.

Pressure Gauges, Indicators, Thermometers, Pyrometers. By James Smith. Published by the Chemical Publishing Co., Inc., 148 Lafayette St., New York City. Size 4 by 6 in.; cloth bound; 142 pp. Price $1.50.

This is a practical handbook for the operating man and the student and covers all forms of pressure gages, indicators, thermometers and pyrometers, liquid level indicators and internal combustion engine indicators. The book is divided into 19 chapters and in addition to descriptions and applications of the instruments themselves, it covers such factors as errors, troubles, instrument testing and installation.

LOW in head room

LARGE in capacity



You'll find the Murray Type "Y" Boiler just the unit to install in cramped quarters. . . Its large steam drum gives liberal steam releasing area for the steam generated. And the boiler is baffled so that the entire heating surface of the main tube bank is exposed to the direct radiant heat of the furnace. . . Write us about your boiler problems.

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MURRAY

Power Plant Construction News

Calif., San Diego—Consolidated Aircraft Corportaion, 3302 Pacific Highway, plans one-story steam power house, 52 x 107 ft., in connection with group of six new one and multi-story additions for large increase in present capacity. Electric power equipment will be installed in different plant units, as well as mechanical-handling facilities. Entire project will cost close to $1,000,000. Edward C. and Ellis W. Taylor, 803 West Third Street, Los Angeles, are architect and engineer, respectively.

Conn., Stamford — Connecticut Power Co., New London, Conn., is considering expansion and improvements in steam-electric power plant serving its Stamford division, including installation of new 25,000-kw. turbine-generator unit, high-pressure boilers and auxiliary equipment. Cost reported close to $3,000,000. Company also will make line extensions in same district.

Conn., Waterbury — Connecticut Light & Power Co., Hartford, Conn., plans new 15,000-kva. condenser unit and auxiliary equipment in power plant at Waterbury. Also will construct a new dock and install coal-handling equipment for power station at Devon, Conn. This is part of 1940 expansion program of company, for which a total fund of about $2,600,000 is being arranged.

Idaho, Sandpoint—Northern Idaho Rural Electrification Rehabilitation Association, Sandpoint, has engaged John W. Cunningham, Spalding Building, Portland, Ore., consulting engineer, to prepare plans for proposed new hydroelectric power plant at outlet of Priest Lake, where site has been secured. Cost estimated close to $150,000. Station will be used for power service for rural electric system. Work scheduled to be carried out in spring.

Iowa, Calmar—Common Council has plans under way for new municipal power plant, for which bids are scheduled to be asked early in April. Proposed to use Diesel engine-generator units and accessories. A bond issue has been arranged for project. Hubbard Engineering Co., 415 North La Salle Street, Chicago, Ill., is consulting engineer.

La., Bogalusa—Gaylord Container Corporation, 2820 South Eleventh Street, St. Louis, Mo., Pulp and Paper Division, plans installation of electric power equipment in connection with expension and improvements in kraft paper and board mill at Bogalusa. Several new production units will be built. Entire project will cost close to $1,000,000. Proposed to begin work at early date.

La., Lake Charles—Continental Oil Co., Ponca City, Okla., plans installation of power equipment in new gasoline refining plant in Westlake district, St. Charles, where large tract of land has been selected. Also will build a power house, pumping station and other mechanical units, including pipe lines for oil transmission and other facilities. Entire project will cost over $2,500,000. Work is scheduled to begin soon.

Md., Vienna—Eastern Shore Public Service Co., Salisbury, Md., has plans maturing for expansion in steam-electric generating station at Vienna, including construction of addition and installation of new 7500-kw. steam-turbine generator unit, high-pressure boiler and complete auxiliary equipment. Work is scheduled for completion early in 1941. Cost estimated close to $1,000,000. Company will also make extensions in transmission lines in Vienna district.

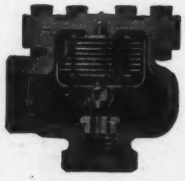
Minn., St. Paul—Northern States Power Co., 15 South Fifth Street, Minneapolis, Minn., has preliminary plans under way for expansion and improvements in steam-electric power plant on waterfront at St. Paul, known as High Bridge Station, with installation of new turbine-generator unit, high-pressure boilers and auxiliaries. Cost estimated close to $4,000,000. Proposed to begin work in spring.

Miss., Meridian—Flintkote Co., 50 West Fiftieth Street, New York, N. Y., manufacturer of roofing products, plans

Nicholson

STAINLESS AND CHROMIUM PLATED STEEL FLOATS

They come in sizes 2½ in. to 14 in. diameter, will withstand pressures up to 2500 lb., deliver trouble free, low cost float service wherever used around the plant. Immediate delivery. Bulletin No. 339.



INDUSTRIAL STEAM TRAPS

Write for New Steam Trap Catalog No. 240

Nicholson Traps give the quick positive action that minimizes wire drawing. They are non-air-binding and non-freezing, work on pressures to 300 lb. Specify them for improved drainage of Unit Heaters, Pipe Coils, Water Heaters, etc.

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160 Oregon St. WILKES-BARRE, PA.

MAGNOLIA METALS

Magnolia Anti-Friction Metal
For all steady high speed and heavy pressure bearings. Runs cool, never scores. Excellent for motors over 10 hp. and all transmission.

Adamant Super-Genuine Babbitt
Recommended for bearings on Diesels, Marine and Airplane engines and for connecting rods. Extraordinarily tough.

Magnolia Isotropic Die-Cast Bronze
Fully machined, cored and solid bars, acid resistant, non-scoring. No blow holes, cracks or spongy metal. Free cutting. Extra tough and long lasting.

MAGNOLIA METAL COMPANY
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SAN FRANCISCO FORT WORTH MONTREAL

installation of electric power equipment in new plant for production of wall board and wood fiber specialties on site near Meridian, consisting of several large units. A power house will be built for mill service. Entire project reported to cost about $2,000,000. Proposed to begin work soon and have plant ready for operation early in 1941. I. J. Harvey, Jr., is president.

Mo., St. Louis—Blanton Co., 318 South Second Street, manufacturer of oleomargarine and kindred products, plans power house at new plant on Wharff Street, extending from Angelrodt to Dock Streets, comprising several one and multi-story units. Work will be carried out in spring. Entire project will cost over $350,000. W. J. Knight & Co., Wainwright Building, are architects and engineers.

Neb., Hastings—City Council plans expansion in municipal waterworks station, including new turbine room addition, with installation of a 35,000-kw. turbine-generator unit and auxiliary equipment. Cost estimated close to $160,000. Also will install switchgear to cost approximately $54,000 and other equipment. Black & Veatch, 4706 Broadway, Kansas City, Mo., are consulting engineers.

N. C., Wilson—Town Council has plans for expansion and improvements in muicipal electric light and power plant, including installation of new turbine-generator unit and auxiliary equipment. Fund of $300,000 has been authorized for work.

N. D., Grand Forks—Nodak Rural Electric Co-operative, Inc., Grand Forks, has approved purchase of site for new electric power plant for service for rural electric system. Plans for station will be completed soon and bids called for equipment. Initial installation will include three 500-kw. Diesel engine-generator units and accessory apparatus, with ultimate plant to have five such units. Ellerbe & Co., First National Bank Building, St. Paul, Minn., are consulting engineers.

Ohio, Newark—Ohio Edison Co., Newark, has plans in progress for expansion in steam-electric generating plant at Philo, to include installation of a new 85,000-kw. cross-compound condensing unit, comprising one high and one low-pressure turbine-generator, hydrogen-cooled; two new high-pressure boilers with rating of 850,000 lbs. of steam per hour, and complete auxiliary equipment. Extensions will be made in transmission lines from Philo plant. Entire project will cost close to $6,500,000 and will be carried out as part of 1940 construction program of company.

Okla., Sand Springs—Sand Springs Textile Mills, Inc., plans installation of electric power equipment in new additions to cotton mills, for which work is scheduled to begin at once. Entire project will cost close to $500,000.

Pa., Oil City—Keystone Public Service Co., has approved plans for addition to steam-electric power plant, to include installation of new 5000-kw. turbine-generator unit and accessories, boiler with capacity of 100,000 lbs. of steam per hour and complete auxiliary equipment. Proposed to begin work in March. Cost close to $250,000.

Pa., Philadelphia—Freihofer Baking Co., Twenty-seventh Street and Indiana Avenue, plans installation of power equipment in new one-story baking plant, 100x200 ft. Also will install traveling ovens, conveyors and other mechanical equipment. Entire project will cost about $100,000. Work will begin soon.

Pa., Reading—Metropolitan Edison Co., Reading, has plans in progress for extensions in steam-electric power plants at Reading and Lebanon, Pa., with installation of turbine-generator units, boilers and auxiliary equipment for large increase in present capacity. Entire project is reported to cost over $3,000,000 and will be part of 1940 expansion program of company. Extensions will be made in transmission lines in different districts, with additional power substation facilities.

S. C., Columbia—South Carolina Electric & Gas Co., Columbia, has authorized an appropriation of $1,100,000 for expansion and improvements in properties during 1940, including power plants, power substations, transmission and distributing lines, and other facilities. Work on program will begin soon.

Tenn., Alcoa—Aluminum Co. of America, Inc., Gulf Building, Pittsburgh, Pa., plans extensions and improvements in hydroelectric generating plants on Little Tennessee River, with installation of equipment for increased capacity. This is part of expansion program of company at different plants and properties, for which an appropriation of about $30,000,000 is being arranged, to be carried out over a period of months.

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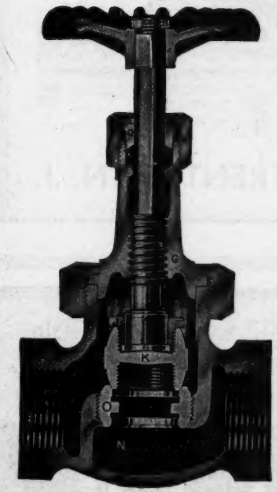

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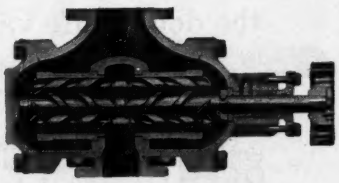

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